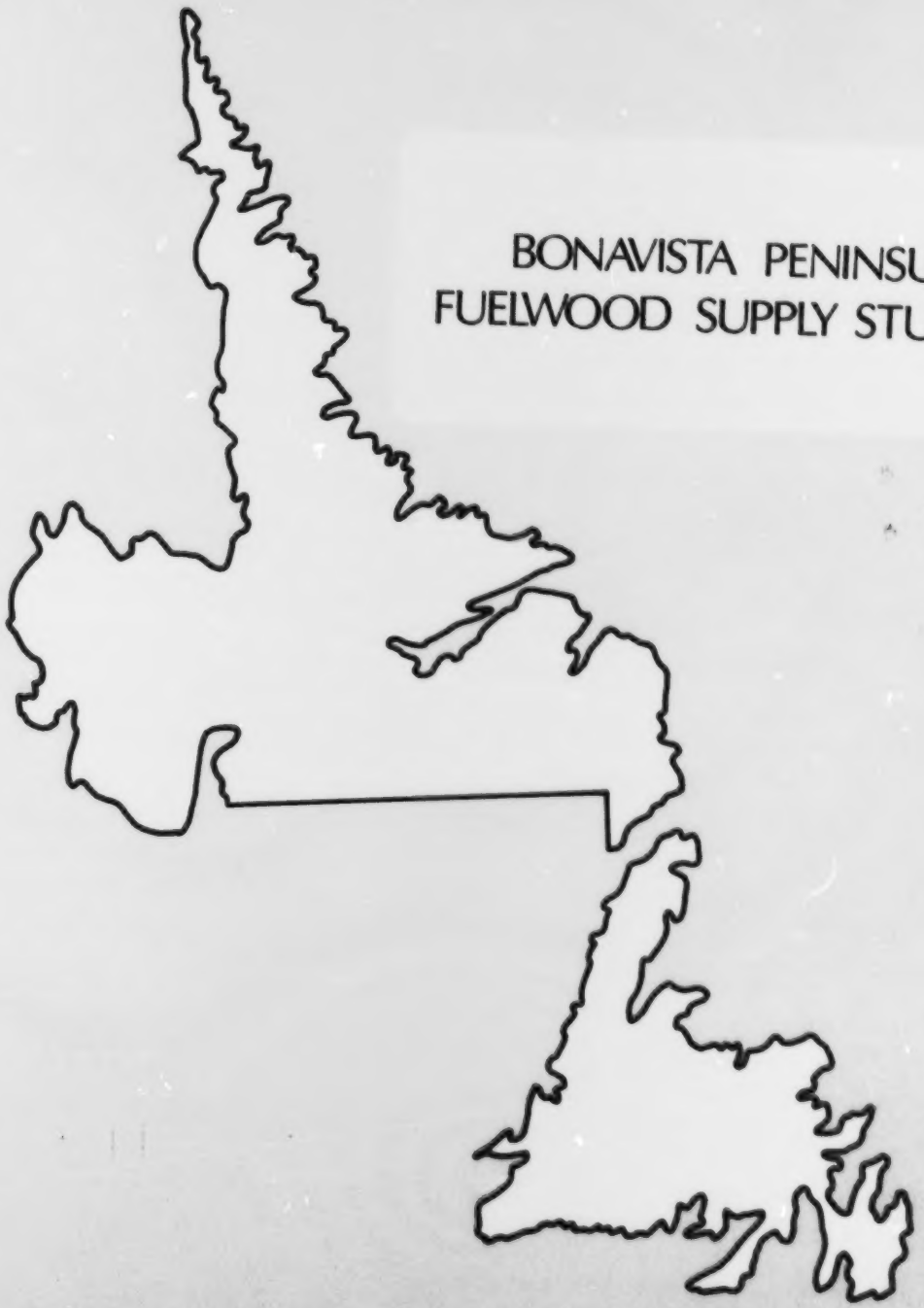
CANADA / NEWFOUNDLAND

CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT



BONAVISTA PENINSULA FUELWOOD SUPPLY STUDY

BONAVISTA PENINSULA FUELWOOD SUPPLY STUDY

Prepared for:

Energy Branch
Department of Energy
Government of Newfoundland and Labrador
P.O. Box 4750
St. John's, Newfoundland
A1C 5T7

Prepared by:

Highlands Contracting Ltd.
P.O. Box 446
Gander, Newfoundland
A1V 1W8

Report No.: CS 85-50
Date: March, 1987

Canada/Newfoundland Conservation and
Renewable Energy Demonstration Agreement

90-03770/

CANADA/NEWFOUNDLAND CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION PROGRAM

Because of the sharp increases in the cost of oil, natural gas and electricity within the past 15 years, the search is on for economical sources of energy. Affordable energy, now and in the future, concerns everyone.

In June 1979, to help meet this demand for conservation and alternative sources of energy, the Government of Canada and the Government of Newfoundland and Labrador signed the Conservation and Renewable Energy Demonstration Agreement (CREDA).

The objectives of this $11,250,000 cost-shared program (Federal 80%, Provincial 20%) included the following:

- to develop and demonstrate promising new technologies which use renewable energy resources;
- to develop and demonstrate new and efficient technologies which conserve energy;
- to create employment in new and existing energy related industries;
- to inform the public of the economical use of new technologies as they apply to the energy resources of Newfoundland and Labrador.

The CREDA program ended March 31, 1985. For more information on this and other energy projects funded under the Canada/Newfoundland CREDA program contact:

Information Section
Energy Branch
Department of Mines and Energy
P. O. Box 4750
St. John's, Newfoundland
A1C 5T7
(709) 576-2411

Energy, Mines and
Resources Canada
Conservation and Renewable
Energy Office
P. O. Box 65
Suite 301, Atlantic Place
215 Water Street
St. John's, Newfoundland
A1C 6C9
(709) 772-5353

PROGRAMME CANADA/TERRE-NEUVE DE DÉMONSTRATION DES ÉCONOMIES D'ÉNERGIE ET DES ÉNERGIES RENOUVELABLES

La montée en flèche du coût du pétrole au cours des 15 dernières années, du gaz naturel et de l'électricité a rendu nécessaire la recherche de sources d'énergie à bon prix. La question de l'énergie à coût abordable, pour aujourd'hui et les années à venir, touche tous les Canadiens.

Pour aider à répondre aux besoins en matière d'économies d'énergie et d'énergies renouvelables, le gouvernement du Canada et le gouvernement de Terre-Neuve et du Labrador ont ratifié en 1979 au Accord de démonstration des économies d'énergie et des énergies renouvelables (ADEEER).

Ce programme a été doté d'un budget de 11,25 millions de dollars, et le gouvernement du Canada et celui de la province s'en partageant les coûts dans une proportion de 80% et 20% respectivement. Quelques-uns de ses objectifs étaient:

—La mise au point et la démonstration de nouvelles techniques prometteuses faisant appel aux énergies renouvelables,

—La mise au point et la démonstration de nouvelles techniques efficaces d'économie d'énergie;

—La création d'emplois dans des entreprises nouvelles ou existantes oeuvrant dans le domaine de l'énergie;

—Faire connaitre au public les avantages économiques de ces nouvelles techniques telles qu'applicables aux ressources énergétiques de Terre-Neuve et du Labrador.

Le programme ADEEER prendra fin le 31 mars 1985. On peut obtenir plus de renseignements sur le programme ou sur les sujets qui ont fait l'objet d'une aide financière en vertu de l'Accord Canada — Terre-Neuve sur les économies d'énergie et les énergies renouvelables en communiquant avec:

Section de l'information
Direction de l'énergie
Ministère des Mines et de l'Énergie
C. P. 4750
St-Jean, Terre-Neuve
A1C 5T7
(709) 576-2411

Energie, Mines et
Ressources Canada
Bureau de la Conservation
et des Énergies Renouvelables
C.P. 65, Bureau 301, Atlantic Place
215 rue Water
St. John's, Terre Neuve
A1C 6C9
(709) 772-5353

Disclaimer

"This publication was prepared under the Canada-Newfoundland Conservation and Renewable Energy Demonstration Agreement which was co-funded by Energy, Mines and Resources Canada and the Newfoundland and Labrador Department of Mines and Energy. Distribution of the report by the funding departments does not necessarily signify that the contents reflect the views and policies of these departments. Any mention of trade names or commercial products does not constitute recommendation or endorsement for use."

TABLE OF CONTENTS

	Page
Introduction	1
Unit Overview	1
Objective and Scope	3
Study Method	4
Potential Fuelwood Sources	5
Biomass Harvesting Plans	14
Analysis of System	20
Discussion	30
Conclusion and Recommendations	33
Bibliography	35
Appendices	36

LIST OF TABLES

		Page
TABLE 1:	Summary of Data by Stand Group	8
TABLE 2:	Mileage Chart – Cutting Block to Plant	9
TABLE 3:	Forest Biomass Requirements	15
TABLE 4:	Summary of Plan Details	19
TABLE 5:	Fuelwood Supply Sources – Year 1	22
TABLE 6:	Productive Machine Hour Costs	23
TABLE 7:	Processed Chip Cost at Roadside – Direct	24
TABLE 8:	Processed Chip Cost at Roadside – Total	25
TABLE 9:	Chip Cost at Plants	26
TABLE 10:	Delivered Chip Cost from Purchased Storage . . .	27
TABLE 11:	Delivered Chip Cost from Contractor's Storage . .	28
TABLE 12:	Delivered Cost from Mill Residue	28
TABLE 13:	Delivered Cost from Independent Operators	29
TABLE 14:	Summary of Delivered Fuelwood Costs	29
TABLE 15:	Non-Recurring Costs (Year 1)	31

LIST OF APPENDICES

		Page
APPENDIX 1:	Terms of Reference for Fuelwood Supply Study for the Bonavista Peninsula	38
APPENDIX 2:	Biomass Tables	40
APPENDIX 3:	Details of Study Method	43
APPENDIX 4:	Calculation Sheets	48
APPENDIX 5:	Study Area Maps	61
APPENDIX 6:	Computer Printouts	67
APPENDIX 7:	Equipment Specifications	129

LIST OF FIGURES

Figure 1, Key Map 13

Figure 2, Harvesting Areas. 18

ACKNOWLEDGEMENTS

The able and willing assistance of Mr. Bill Alexander, Unit Forester, and Mr. Cliff Briffett, Senior Inventory Technician of Forest Management Unit 2, must be acknowledged. The co-operation of the study supervisors, Mr. John Drover, P.Eng. and Mr. Phil Graham, P.Eng., of the Energy Branch, Department of Mines and Energy, was also gratefully appreciated.

SUMMARY

This study was designed to produce a cost per tonne for delivered fuelwood chips on the Bonavista Peninsula. In the first stages, localized forest biomass harvesting blocks were developed from a widely dispersed pattern of stands within Forest Management Unit 2. These blocks, which had been deemed unsuitable for conventional harvesting, were assessed along with mill residue sources. Fuel harvesting, processing, transportation and delivery machinery were reviewed and refined to components and systems whose production was compatible with projected requirements (i.e. 15,000 green tonnes). Biomass harvesting data was correlated with machine and systems data and analyzed.

A fuelwood supply in excess of 50 years was established. One- and five-year harvesting plans identified sites for summer operations in the Ocean Pond area and winter operations on the Bloomfield Access Road. The average cost to deliver fuelwood chips and mill residue to end-users on the Bonavista Peninsula is $27.40/green tonne or $49.81/oven-dry tonne.

An important result of the study is that 12 permanent jobs would be created as a result of the chip supply operations.

RÈSUMÈ

UNIT 2 FUELWOOD STUDY

L'ètude a ètè entreprise dans le cout de dèterminer le cout de la production (par tonne) de copeaux a la Clarenville Forest Management Unit (Unit 2). On a ètabli que la rèserve de bois de chauffage serait suffisante pour 50 ans en se foudant sur les besoine annuels prèvus a cet égard (15,000 tonnes vertes). On estime que le cout moyen de la livraison de copeaux de bois de chauffage et de rèsidus d'usine aux utilisateurs finals de la pèninsula de Bonavista est de 27,40 $ la tonne verte et de 49,61 $ la tonne anhydre.

INTRODUCTION

Under the Canada/Newfoundland Conservation and Renewable Energy Demonstration Agreement, funds have been allocated to encourage conversion from fossil fuels to alternate energy sources. One of the alternates being considered is woody biomass which is renewable, generally under-utilized and fairly readily available in this province.

The Department of Mines and Energy, as program administrators for the province's segment of this federal initiative, has undertaken to investigate the feasibility of converting a number of commercial and industrial boiler plants in the Bonavista Peninsula region (Figure 1) to wood-burning systems with the view of demonstrating a complete fuelwood supply and utilization infrastructure.

As part of the preliminary review, the Department engaged Highlands Contracting Ltd. to conduct an analysis of biomass availability, harvesting, chipping, transport, off-loading and storage elements of this potentially significant socio-economic opportunity.

UNIT OVERVIEW

The Clarenville Forest Management Unit (Unit 2), like other units in the province located either outside or on the fringe of the economic wood supply zone of the pulp and paper mills, has historically had a market for only a limited segment of its forest resource (i.e. sawlogs for lumber production). The local lumber market has remained reasonably stable (lumber production varies from 7 million f.b.m. in healthy market conditions to 5 million in poor times), largely because of the Unit's strategic location adjoining the major Avalon market. This industry is important to the local economy even when wholesale lumber prices are depressed, but the sawlog harvest

does exact a toll on the forest and reduces the profitability of subsequent harvesting operations.

Generally, logging operators pick over stands for suitable sawlog material (termed "highgrading") and, all but the few who use their chainsaws and logging machinery very discriminately, have a significant adverse impact. The practice has led to degradation of the growing stock in most of the more accessible stands and has resulted in a situation where forest sites are producing fiber at a rate considerably below their potential.

Clearcutting is practiced to a very limited extent and has generally been restricted to pockets of sawlog-size timber. Some of the more extensive clearcuts have been dramatically under-utilized. As much as 53 m^3 per ha (9 cords per acre) of merchantable wood has been left on some sawlog cutovers.

The net effect of such practices has, of course, been the diminution of the economic value of the resource in absolute terms. Nonetheless, in relative terms, the Unit does exhibit a number of characteristics which should be conducive to forest resource development.

The Clarenville Unit has an extensive network of primary and secondary highways in close proximity to much of its productive forest area. The forest access road construction efforts of the Unit have placed it in the rather desirable position of being slightly ahead of current demand. Harvesting is also facilitated by the fact that there are few particularly adverse terrain conditions and no major climatic deterrents such as consistently heavy snowfall accumulations.

Softwood stands account for 88 per cent of the productive forest area. Just over half contains balsam fir (Abies Balsamea (L.) Mill.) with virtually all of the remainder being black spruce (Picea Mariana (Mill.) B.S.R.) which is considered to be in a healthy

condition. The Unit is dramatically undercut. The average annual harvest in recent years has been in the order of 40,000 m^3 (or roughly 15,000 cords). This is only about 25 per cent of the calculated net annual allowable cut.

There is a substantial woods labour force and harvesting-oriented entreprenurial base which, while not geared to an intensive harvesting effort, has demonstrated the potential to capitalize on expanded opportunity. There was a very significant export operation in square timber around the World War Two period which far surpassed logging activity during any period for the next 30 years. More recently, around 1980, there was a brief resurgence of export activity with 6,000 cords of pulpwood and 1,700 cords of specialty roundwood products being harvested. This amounted to a 33 per cent increase in the average annual cut and was accomplished largely through the efforts of local business and labour with virtually no direct public financial assistance.

OBJECTIVE AND SCOPE

The objective of the study was to assess the amount of wood fuel, in areas of Forest Management Unit 2 designated by the Unit Forester, that could be technically and economically recoverable and to identify the infrastructure necessary to process the fuel and supply it to potential consumers.

The scope of the work is detailed in Appendix 1 and summarized as follows:

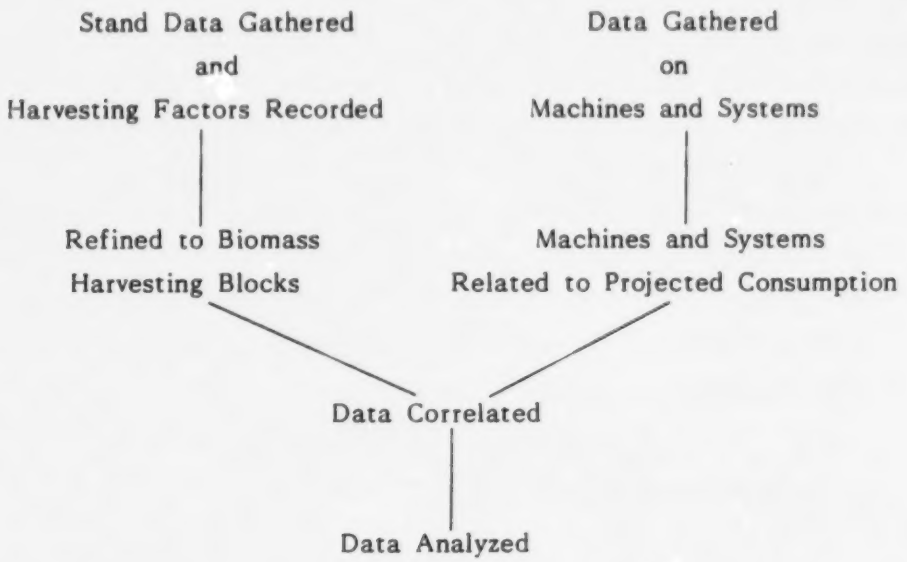
1. Assess designated forest areas and establish whether such areas are technically and economically recoverable for fuel chip production. The assessment is to include sawmill residue.
2. Investigate harvesting/chipping options and establish costs.
3. Investigate handling, transportation and storage systems and establish costs.

4. Provide a one-year operating plan, plus a five-year harvesting plan.

5. Prepare a final report.

STUDY METHOD

The study method is summarized as follows:



Stands designated by the Unit Forester were subjected to preliminary evaluation on the basis of conventional harvesting criteria. This screening reduced the area under consideration to stands and groups of stands which exhibited no major harvesting impediments. Mass per area values (developed in Appendix 2) were applied to the various stratum to determine gross estimates of available biomass on a block or stand group basis. Field checks were carried out on stands from all blocks.

Data was gathered on harvesting, chipping and transportation equipment and systems. A preliminary screening was then conducted to eliminate both machines and systems whose production could not be

roughly correlated with the projected fuel chip consumption for the study. Cost data was generated for a range of options.

All data was then correlated and an analysis undertaken.

A detailed description of the study method is outlined in Appendix 2.

POTENTIAL FUELWOOD SOURCES

Potential sources of supply can be separated into two fuelwood categories – mill residue and forest biomass. The first to be considered shall be mill residue since there are over 500 licenced sawmills plus a number of major planer mills in Forest Management Unit 2. Forest biomass shall then be discussed on a stand group basis.

Mill Residue

While the sawmill may be uniquitous in Unit 2, there are only 40 mills which produce over 50,000 f.b.m. per annum. The remainder are very small producers although they do account for nearly half the sawmill production in good years. The top 40 mills produce 3-3.5 million f.b.m. with a few of the largest each accounting for 300,000 to 400,000 f.b.m. of this amount.

The bulk of the logs are sawed into "squares" in the woods with a substantially smaller volume being hauled in roundwood form to central mills for processing. Where sawmill sites are accessible, the major residue component – slabs – are generally retrieved for firewood. This leaves only modest piles of sawdust which are generally not worth recovering. Thus, backlogged sawmill residue is of little value as a potential fuelwood source. Further, the current and future supply of such residue is a questionable source. The slab demand is likely to remain strong and the mills to remain small and disbursed.

There are a number of planer mills, largely concentrated in the Goose Bay area, which have accumulated significant masses of wood residue. An estimate of recoverable backlogged residue has been placed at 2,000 green tonnes (based on company experience and conversations with several local operators). This is only a portion of the total accumulated residue but it does represent that portion which is likely to be recovered in a clean state. Most of the residue that has been pushed away from the planer chute is mixed with dirt and debris and is worthless as a commercial fuelwood source.

It is unlikely that all of the planer mill operators shall be enthusiastic about maintaining a stockpile of clean residue at the outset of the program. Projected current mill residue has been set at 1,000 tonnes for the first year of operation and 2,000 tonnes for the next couple of years. It is theoretically possible that additional residue could be recovered but the supply from the smaller mills would be tenuous and has been omitted.

Forest Biomass

The pattern of stand groups (calculations in Appendix 4) which developed from the initial screening procedure indicated that the harvesting assessment should be concentrated primarily on several of the established operating areas. These areas are identified in Figure 1 and illustrated in more detail on the 1:30,000 scale maps of Appendix 5.

There are several characteristics common to nearly all areas and these are worthy of note before proceeding with individual descriptions. Stands or stand segments within close proximity to serviceable roads, especially those within 200 to 250 m of either side of such roads, are normally very heavily picked over and would provide a poor logging chance. They have been excluded from the evaluation. Virtually all other stands within the study areas have

been cut to varying degrees (highgraded) for sawlogs. There are no undisturbed second growth stands. Conventional cutovers are uncommon and where they are to be found are very limited in extent. There is an extensive network of trails through nearly all of the stand groups but few of these could be used for intensive harvesting without upgrading.

Quantitative stand data, developed for the various stand groups or blocks, is summarized in Table 1 and presents key determinants which shall be central to the priorization of harvesting blocks. These are (1) average mass per unit area (Mass/Area); (2) per cent of total stand area recommended for integrated harvesting (Per cent Integrated); and (3) the average mass which shall be recoverable per km of new haul road on each block (Mass/km).

It should be noted that the mass for each stand group or block represents only that portion of the mass of the stand which would be available for fuel chips (i.e. the mass of the conventional merchantable component of the stand has been excluded). The total new haul road required to access each block is presented under the heading "Haul Road". All stands or stand segments within an average hauling distance of 450 m of a forest access road that had not been heavily highgraded were grouped as a harvesting unit and are presented under the name of that access road. All potential harvesting blocks are illustrated on 1:30,000 maps in Appendix 5 and presented in Table 1. They are referenced to communities with potential conversion sites in the mileage chart of Table 2.

Generally, a number of blocks were identified within each major operating area. They shall be disucssed collectively, where practicable, in the descriptions which follow. The first of the groups or blocks to be discussed are located to the west of Clarenville in close proximity to the Trans-Canada Highway. All are within 25 km of Clarenville.

TABLE 1

SUMMARY OF DATA BY STAND GROUP

Location	Map No.	Area[1]	Mass[2]	Mass/Area[3]	Per cent[4] Integrated	Haul[5] Road	Mass/km[6]
Block 1	1	227.3	21,655.7	95.3	0	3.7	5,852.9
Block 2	1	87.1	5,950.7	68.3	0	0.9	6,611.9
W. Hills Rd.		47.6	3,788.8	79.6	0	–	–
Block 3	1	409.3	38,792.9	94.8	22	4.0	9,698.2
Block 4	1	139.4	10,317.4	74.0		2.0	5,158.7
Block 5	2	317.8	23,744.4	74.7	83	–	–
Block 6	3	295.9	26,793.8	90.6	0	2.4	11,164.1
Block 7	3	213.8	19,035.1	89.0	18	1.7	11,197.1
Block 8	3	148.1	14,367.6	97.0	0	1.1	13,061.4
G's Bk. Rd.		91.7	9,267.6	101.1	73	–	–
Block 9	3	291.6	17,922.8	61.4	0	1.9	9,433.1
Block 10	3	102.1	13,814.5	135.3	0	0.7	19,735.0
Block 11	3	522.2	45,794.2	89.5	43	6.4	7,299.6
Block 12	3	99.6	9,005.3	90.4	0	–	–
B'field Rd.		54.4	4,944.7	90.9	0	–	–
Block 13	4	492.0	50,752.5	103.2	19	2.7	18,797.2
Block 14	4	191.1	19,807.9	103.7	6	1.2	16,506.6
Block 15	4	165.5	18,478.3	111.6	0	1.1	16,798.4
Block 16	5	306.4	28,485.0	93.1	0	2.0	14,242.5
Block 17	5	217.8	22,304.1	102.4	74	2.3	9,697.4
Block 18	5	127.3	12,128.5	95.3	36	1.0	12,128.5
TOTAL		4,548.0	417,151.8			35.1	

[1]Area: in ha

[2]Mass: in O.D. Tonnes

[3]Mass/Area: Average mass per unit area in O.D. Tonnes/ha

[4]Per cent Integrated: Per cent of total area designated for integrated logging

[5]Haul Road: New Haul Road construction required to access each block

[6]Mass/km: Average recoverable mass per km of new haul road.

TABLE 2

MILEAGE CHART – CUTTING BLOCK TO PLANT (KILOMETERS)

	Arnold's Cove	Clarenville	Charleston	Catalina	Bonavista	Haul Road [1]
Block 1 (White Hills)	68	18	–	–	–	(7.0)
Block 2 (White Hills)	66	16	–	–	–	(5.0)
White Hills Rd.	67	17	–	–	–	(6.0)
Block 3 (Shoal Hr. O'Pass)	61	11	–	–	–	(2.0)
Block 4 (Thorburn Lk.)	74	24	–	–	–	(0.5)
Block 5 (Dark Hole Bk.)	60	10	–	–	–	(4.0)
Block 6 (Geo's Bk. Rd.)	72	22	39	86	102	(5.0)
Block 7 (Geo's Bk. Rd.)	73	23	40	87	103	(5.5)
Block 8 (Geo's Bk. Rd.)	77	27	44	91	107	(10.0)
George's Bk. Rd.	74	24	41	88	104	(7.0)
Block 9 (B'field Rd.)	84	34	30	78	94	(4.5)
Block 10 (B'field Rd.)	88	38	34	82	98	(7.5)
Block 11 (B'field Rd.)	93	43	39	87	103	(13.0)
Block 12 (B'field Rd.)	92	42	38	86	102	(11.5)
Bloomfield Rd.	92	43	39	87	103	(13.0)
Block 13 (Ocean Pd.)	[2]105/119[3]	55/69	48/24	99/57	115/73	(28/14)
Block 14 (Ocean Pd.)	105/115	56/65	52/18	100/53	116/69	(29/10)
Block 15 (Ocean Pd.)	102/115	52/68	48/21	96/56	112/72	(25/13)
Block 16 (Blackhead Bay)	–	–	–	14	30	(1.0)
Block 17 (Blackhead Bay)	–	–	–	28	54	(1.0)
Block 18 (Blackhead Bay)	–	–	–	27	53	(0.5)

[1] Access road distance from block or stand group to major highway.

[2] Distance via Lethbridge Access Road.

[3] Distance via Ocean Pond Access Road.

The White Hills Access Road area (Blocks 1 and 2 plus stands near the road corridor) has been logged over primarily for sawlog. The more accessible pockets of birch have also been removed, for both domestic and commercial purposes. The area is accessed by approximately 6.4 km of Class 'C' forest access road. The stands are largely of the mixed softwood-hardwood type and are generally open in nature. The general area is quite hilly but this has not proved overly detrimental to either logging or road building.

Block 3 adjoins the Trans-Canada Highway and Shoal Harbour River. Sawlog highgrading has occurred throughout the block and some firewood cutting has taken place near the highway. The stands are quite similar to those at White Hills but represent a significantly greater recoverable mass per km of new haul road. Road-building conditions would be good and, as in White Hills, the slope runs with the load.

Block 4 consists mainly of one large hardwood-softwood stand of open crown density. The general area is quite level and the block can be reached by way of a rough, sub-standard haul road in periods of dry weather. Average mass per ha is moderately low but the block holds some promise by virtue of its location and the fact that the existing road could probably be upgraded at modest cost for seasonal extraction.

The Dark Hole Brook Access Road area is one of the few reasonably accessible, yet relatively undisturbed, tracts of timber in the entire Unit. It has been opened up by a recently completed 6 km Class 'C' access road but has not yet been made available to local sawlog operators. If it could be held until pulpwood and chip markets are developed it would provide an excellent opportunity to demonstrate the economics of an integrated sawlog-pulpwood-fuel chip operation with 40 per cent of the biomass going for conventional products and the remainder being made available for fuel chips.

The George's Brook Access Road operating area has four separate stand groups identified over the 10.6 km Class 'C' road (Blocks 6, 7 and 8 plus the stands accessible from the road). The construction of haul roads to each of these blocks could be accomplished with relative ease. Virtually all of the stands which make up the blocks are either softwood-hardwood or hardwood-softwood types. They have been highgraded for sawlogs. The stands which are accessible from the access road itself are largely black spruce which is of pulpwood size. A pulpwood market would probably be required before these stands were harvested. Overall terrain conditions are quite moderate and present no significant impediments to logging. Blocks 6 and 7 are situated close to the Bonavista Peninsula Highway with Block 6 being in an especially attractive location for winter harvesting. Block 7 is on the route of the proposed arterial road between the Trans-Canada and Bonavista highways.

The Bloomfield Access Road operating area had four blocks identified along with one stand group directly accessible along the old section of the access road. There are no significant impediments to haul road construction and all haul roads connect to the original 10.9 km of main Class 'C' access road. All blocks have been picked over for sawlogs.

Blocks 9 and 10 lie on a moderate slope which inclines toward the access road. Block 9 is mainly a mixture of balsam fir and black spruce of moderate height and open crown density. Block 10 is largely the softwood-hardwood type with trees of significantly bigger size than those of the former block. It is also open in nature as is Block 12 which is a mixture of softwood-hardwood and hardwood-softwood stands.

Block 11 is the only one in the operating area containing stands that could be used for products other than chips. Nearly half the stand area has been designated for integrated harvesting. The block is fairly hilly and would require either an extensive new haul

road network or a substantial reconstruction effort on the existing haul roads. Retrieval of chip material would have to be carried out in conjunction with conventional logging to make this block economically attractive.

The Ocean Pond operating area is made up of three blocks (13, 14 and 15) whose stand composition is distinctive from that of the stand groups which have been described. The predominating stand type is dense balsam fir in the 8-10 m height class, commonly referred to as "rail stands." This is virtually the exclusive stand type through Blocks 13 and 15. Block 14 is a mixture of this type of material and softwood-hardwood stands which have been picked over for sawlogs.

These Blocks are somewhat more remote than those in the other operating areas being 30 km from the Bonavista Highway at Lethbridge (i.e. the Lethbridge Access Road) and 10 km from the highway at Southern Bay (i.e. the Ocean Pond Access Road) over a winding and hilly route. Because they are less readily accessible, the main access roads through the blocks can be utilized to a much greater extent since the stands are largely intact to roadside. The general area has rougher terrain than the other locals but would not prove overly restrictive to logging operations. In total, the area exhibits the best logging chance of the entire group.

Three blocks (16, 17 and 18) were identified in the Blackhead Bay area near Bonavista. These are exclusively softwood stands and are a mixture of balsam fir and black spruce. Haul roads shall prove more difficult to construct in this area. Surface bedrock and limited surfacing materials shall present some problems but will not prohibit road construction. Block 17 and, to a lesser extent, Block 18, would have to be utilized through integrated harvesting. Since there shall, in all probability, be no pulpwood market in this area, integration could be limited to sawlogs and wood chips.

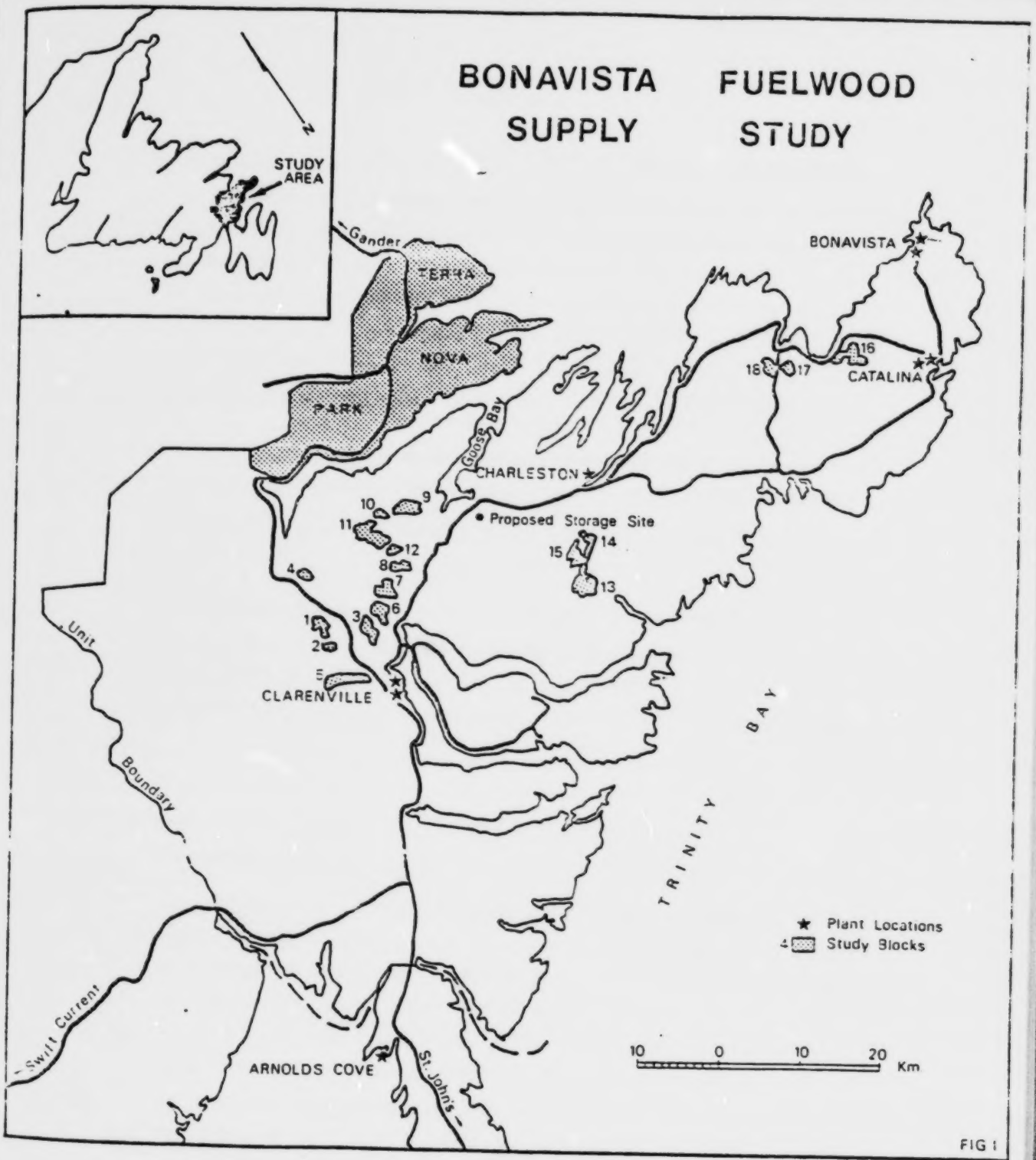

BONAVISTA FUELWOOD SUPPLY STUDY
STUDY AREA
Gander
TERRA
NOVA
PARK
Goose Bay
CHARLESTON
BONAVISTA
CATALINA
16
17
18
Proposed Storage Site
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
CLARENVILLE
Unit
Boundary
Swift Current
ARNOLDS COVE
St. John's
TRINITY BAY
Plant Locations
Study Blocks
10 0 10 20 Km

FIG 1

BIOMASS HARVESTING PLANS

The quantity of fuel oil to be considered for replacement in this study was set at 600,000 gallons, either #2 or #6 fuel type. The approximate conversion factor was assumed to be 40 gallons[1] of fuel oil per green tonne of fuelwood (figure provided by Department of Mines and Energy staff). The factor assumes a 45 per cent moisture content on a green basis. This is the approximate value determined by both paper companies in the province in fuel demonstration projects.

The determination of biomass requirements was developed as follows:

Fuelwood Requirement = 600,000 gallons/40 gallons per green tonne
= 15,000 green tonnes

Projected Requirements (Year 1):		15,000 green tonnes
Mill Residue – backlogged:	2,000 tonnes	
– current:	1,000 tonnes	-3,000 green tonnes
Forest Biomass (Year 1):		12,000 green tonnes
Projected Requirements (Beyond Year 1):		15,000 green tonnes
Mill Residue – backlogged:	0 tonnes	
– current:	2,000 tonnes	-2,000 green tonnes
Forest Biomass (Beyond Year 1):		13,000 green tonnes

These figures were converted to an oven-dry weight basis using the formula:

$$W_{OD} = W_G - (M.C.)\ W_G$$

Where W_{OD} = Weight (oven-dry)

W_G = Weight (green)

M.C. = Moisture Content

The figures are presented in Table 3. At a biomass consumption level of 13,000 green tonnes per annum (7,150 tonnes O.D.) the harvest

---

[1] A 40 gals/tonne conversion factor relates to #2 oil. (Most plants on the Bonavista Peninsula use #2 oil.)

represents a drain of roughly 2 per cent of the total volume identified for the study as summarized in Table 1. In other words, the harvest could be maintained in perpetuity from within the study area if an allowance for growth was incorporated.

To finalize harvesting plans it was necessary to establish the winter and summer biomass harvesting requirements. Those values (Table 3) were set from the assumption that 75 per cent would be harvested during June to December (summer harvest) with 25 per cent during the winter harvest. The assumption was based on the fact that most of the potential consuming plants under consideration used the bulk of their fuel during the spring to fall season (i.e. the normal processing season).

TABLE 3
FOREST BIOMASS REQUIREMENTS

	YEAR 1		BEYOND YEAR 1	
	Tonnes (Green)	Tonnes (Oven Dry)	Tonnes (Green)	Tonnes (Oven Dry)
Total Harvest	12,000.0	6,600.0	13,000.0	7,150.0
Summer Harvest	9,000.0	4,950.0	9,750.0	5,362.5
Winter Harvest	3,000.0	1,650.0	3,250.0	1,787.5

The selection of harvesting areas would normally be made with due consideration given to the location of the end-users and the quantity each required. Since this is part of a preliminary assessment and the end-users have not yet been confirmed, it was assumed that unspecified quantities of chips would be delivered to plants in each community under consideration. Under this scenario, it was considered practical to concentrate the harvesting over as limited an area as possible, as would be the case with conventional logging, and to select the stand groups or blocks which gave the best overall, rather than localized, logging chance.

The data in Table 1 formed the basis for this analysis and

suggested that the Ocean Pond blocks were the most suitable in terms of overall mass per area and recoverable mass per km of new haul road. In addition, they contained a small percentage of stands designated for integrated logging and were, therefore, not dependent on other markets. The only significant negative consideration for this area was the matter of access to the Bonavista Peninsula Highway. The branch of the access road to Lethbridge, while exhibiting good hauling characteristics, represented a 30 km haul. The branch to Southern Harbour (Ocean Pond Access Road), on the other hand, was only 10 km in length but was substandard. It could, nevertheless, be utilized and is expected to be upgraded once market conditions warrant such an expenditure. Thus, access should prove to be a short term limitation, at the very worst.

The three Ocean Pond blocks (13, 14 and 15) are similar in terms of stand and terrain characteristics and would all provide reasonable logging chances. The selection of one of the three as a starting block came to be determined on the basis of relative operational simplicity.

Block 15 was determined to be marginally better in several respects. It had no acerage designated for integrated logging – a requirement that would complicate the operation at startup. The stands would more likely remain intact until required for harvest than would those of the more accessible Block 13 which had already been subjected to domestic roadside cutting. About 60 per cent of the block could be harvested from the access road and if operational problems were encountered in the early stages, haul road construction could be delayed to year three without moving from the block.

The operating contractor should be required to construct his own haul road and be provided with the authority to restrict access for the duration of the harvest. This would mean that the Crown would have to confer limited proprietary rights to the contractor but is essential if the Unit Forester is to regulate a balanced harvest

between stands with readily accessible and those with more remote biomass.

Operating in the Ocean Pond area in winter would prove difficult, so a winter cutting block in the general area was identified. Block 10 on the Bloomfield Access Road was chosen (Appendix 5). It had a very high mass per area, and average mass per km of new haul road. It was designated exclusively for chipping and was situated in a location which could normally be reached without difficulty in winter. Block 10 contained sufficient mass to provide five years of winter harvesting and would require only 0.7 km of new haul road.

In the event that additional winter harvesting would be required (i.e. the 25 per cent winter allocation proved overly conservative), Block 6 to the south of the George's Brook Access Road could be readily utilized. This block, which adjoined the main branch of the access road, was only 3 km from the Bonavista Peninsula Highway and contained a total mass more than double that of Block 10.

Plan Details

The projected harvesting pattern is delineated in Figure 2 for both summer and winter operating areas and assumes a biomass utilization which is 75 per cent of the tabulated values. The location of operations in year one has been demarkated separately. In the case of the summer operating area at Ocean Pond the contractor shall not be required to incur any haul road construction cost during the first season of operation. Approximately 0.4 km of haul road shall have to be constructed to the Bloomfield Road block (#10) and should be completed prior to the winter season.

It is advised that an operational biomass survey be completed prior to the commencement of harvesting, as is the case with conventional logging. This would permit detailed, localized adjustment of the management inventory (i.e. Unit) data which has been based upon minimal field sampling. It would also refine the stand typing

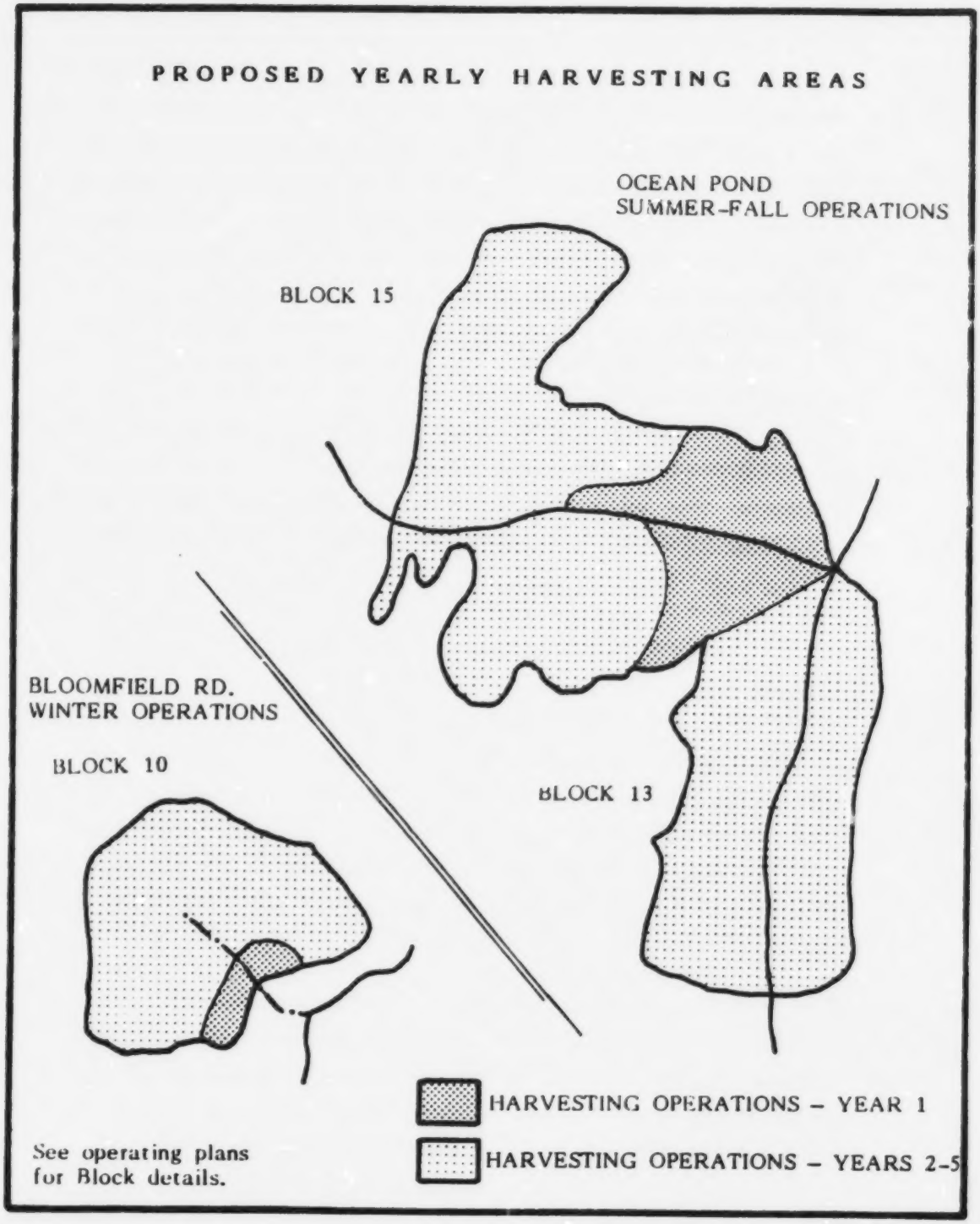

PROPOSED YEARLY HARVESTING AREAS
OCEAN POND
SUMMER-FALL OPERATIONS
BLOCK 15
BLOOMFIELD RD.
WINTER OPERATIONS
BLOCK 10
BLOCK 13
HARVESTING OPERATIONS – YEAR 1
HARVESTING OPERATIONS – YEARS 2-5
See operating plans
for Block details.

FIG. 2

and lead to the production of a highly reliable, localized stand type map. This may suggest to the contractor that adjustments to the operating area would be desirable and such suggestions should be given due consideration as is now the practice with conventional logging plans. The important point to be borne in mind is that the contractor should be permitted to keep road and landing construction costs to an absolute minimum during the startup year.

The plan provides for a shift of summer operations from Block 15 to the adjoining Block 13 in year four. The shift could be delayed to year five if the contractor finds it economical to harvest a 67.0 ha stand immediately adjoining and to the south of the Lethbridge branch of the access road in the western section of the block. This is a very dense stand where the average tree height (3.5 to 6.5 m) is significantly less than that of adjoining stands. Such stands have not been harvested, even in demonstration chip-harvesting trials in this province, and have, therefore, not been specifically designated.

In any event, operations could proceed in Blocks 13 and 15 through years four and five without any additional haul road being required. Similarly, the winter harvesting block (#10) should have been provided with adequate major haul road access by the end of year three (with 0.3 km in that year) and require no major construction for the duration of the five-year planning period.

A summary of the primary elements of the one- and five-year plans is presented in Table 4 which follows:

TABLE 4
SUMMARY OF PLAN DETAILS

Period	Location	Haul Road
Year 1 (Summer	Block 15	0
Year 1 (Winter)	Block 10	0.4 km
Years 2-3 (Summer)	Block 15	1.1 km
Years 2-3 (Winter)	Block 10	0.3 km
Years 4-5 (Summer)	Block 13	0
Years 4-5 (Winter)	Block 10	0

ANALYSIS OF SYSTEM

The projected annual fuel chip requirement of 12,000-13,000 green tonnes, established earlier in the report, served to restrict the fuel chip processing options and to define the range of harvesting and chipping equipment and which should be evaluated in detail.

The modest production requirement suggested that central processing held little merit. Central processing is usually associated with sophisticated mechanical systems operating at a high level of production. It is highly capital intensive, in terms of both equipment and support structure, and has a very limited manpower component. In northeastern North America, central processing has invariably been introduced where either the woods labour costs were moderately high or the woods labour supply had been seriously depleted – situations which are not applicable to Unit 2. It has been virtually the exclusive domain of operators with substantial capital resources such as prime contractors for major forest industries or the companies themselves.

Another approach which was rejected following initial review was terrain chipping. While it is the state of the art in Scandinavian countries, it is unproven in Newfoundland forest conditions. There is but one terrain chipper in the province. It is being tested by the Department of Forest Resources and Lands and its production has yet to approach an acceptable level. However, this trial has good prospects if successful.

With these options eliminated, only roadside chipping remained. Medium- to high-capacity chippers (150 green tonnes per shift and up) and associated harvesting equipment were then quickly screened since they would have provided excessive surplus production capacity (vs. actual acerage requirements of less than 65 green tonnes per shift) and saddled the operator with a seriously over-capitalized system.

The harvesting equipment selection was, thereby, narrowed to feller bunchers, short-wood forwarders, grapple and choker wheeled

skidders. These were grouped in the following systems for whole tree extraction to roadside:

1. Feller buncher and short-wood forwarder.
2. Feller buncher and choker wheeled skidder.
3. Feller buncher and grapple skidder.
4. Manual felling and short-wood forwarder.
5. Manual felling and choker wheeled skidder.
6. Manual felling and grapple skidder.

All six combinations could provide an adequate supply of whole trees to roadside but most are unproven in terms of production and costs under Newfoundland operating conditions. Only one feller buncher in the required production range, is being used in the province. This is a Morbell feller buncher now under trial with the Department of Forest Resources and Lands. The trial, which began in early summer of this year, is providing promising results but winter performance and overall performance have not yet been established. Thus, the feller buncher had to be excluded along with systems 1 to 3. The exclusion of system 4 was based upon the findings of a Forestry Department trial (Buggie, 1982) conducted in the Lewisporte area. In this trial a forwarder had been modified to permit it to haul whole trees felled manually, but production was sufficiently limited so that the system was replaced in a subsequent trial by a grapple skidder/feller buncher combination.

Possible options were, thus, reduced to the skidding systems, both grapple and choker, with manual felling. It is recognized that grapple skidding with manual felling is a most impractical combination; however, the unit cost for the cutters would cover the unit feller buncher cost of production if the 100 tonne per day range became necessary. This option was incorporated into the analysis.

The analysis details the cost elements from the forest to the plant storage units for year one of the project and is based on the following criteria:

1. That 600,000 gallons of #2 and #6 fuel oil is to be displaced at plants in the candidate communities.

2. That this represents 15,000 green tonnes of fuel chips at a 45 per cent moisture content (green basis).

3. That the 45 per cent moisture content, established at experiments performed by both paper companies in the province, is applicable to Unit 2 forest biomass.

4. That the skidding systems, both choker and grapple, are considered most suitable for the forest phase production run.

5. That while the grapple skidder analysis includes manual felling, the cutter cost will cover feller buncher costs at 100 tonnes per day.

6. That haul road construction costs $10,000 per kilometer.

7. That $100 per shift is included for the cutter's wages, power saw, and fringe benefits.

8. That 75 per cent of the total biomass shall actually be processed into chip form.

9. That processed forest biomass, both wood chips from logging operations and mill residue, shall be delivered to all five communities.

The preceding section (Biomass Harvesting Plans) identified fuelwood supply categories. These categories have been broken down for year one and are presented in Table 5.

TABLE 5
FUELWOOD SUPPLY SOURCES – YEAR 1

Sources	Production[1]	Balance[1]
		15,000
Mill Residue – backlogged	2,000	13,000
– current	1,000	12,000
Prime Contractor, summer-fall operation (June-December, Block 15) (7 mo. x 21 days/mo. x 50 tonnes/day)	7,350	4,650
Prime Contractor, winter operation (January-March, Block 10) (3 mo. x 21 days/mo. x 50 tonnes/day)	3,150	1,500
Small Operators	1,500	0
	15,000	0

[1] Mass in green tonnes.

The Table illustrates that the prime contractor shall be the key supplier and suggests that the costs identified for this operation shall be the key determinant in establishing the overall fuelwood cost. For this reason, it shall be analyzed in detail beginning with the determination of productive machine hour costs.

Productive machine hour costs were computer generated, as detailed in Appendix 6 and are presented in Table 6.

TABLE 6
PRODUCTIVE MACHINE HOUR COSTS

Equipment	$PMH
Timberjack 350 Grapple Skidder	46.50
Timberjack 230 Choker Skidder	34.77
Clark 664D Cable Skidder	38.01
Clark Model 665D Grapple Skidder	43.38
Trelan Model C-14, 14" Chipper	44.28
Trelan Model DL-18, 18" Chipper	72.65
Morbark 550, 18" Chipper	69.58
Morbark Model 12, 12" Chipper	49.85

Specifications for these pieces of equipment are provided in Appendix 7 along with equipment considered to have good future prospects. It should be noted that the Timberjack 230 is considered fairly representative of the choker wheeled skidders in Unit 2. As well, the brand names used could be replaced with comparative equipment.

The productive machine hour costs formed part of the input for the computer analysis. The analysis costed machine combinations for the two systems which are:

1. Manual fell/choker wheeled skidder/chipper (12" or 14" capacity). Production: 50 tonnes per eight-hour shift.
2. Manual fell or feller buncher/grapple skidder/chipper (18" capacity). Production: 100 tonnes per eight-hour shift.

The resultant production costs (dollars per green tonne) are presented in Table 7. Related computer printout is provided in Appendix 6.

TABLE 7

PROCESSED CHIP COST AT ROADSIDE – DIRECT

System	$/Tonne
Production of 50 tonnes per 8-hour shift:	
Manual Fell/Timberjack 230E/14" Trelan Chipper	12.70
Manual Fell/Clark Cable Skidder 664D/14" Trelan Chipper	13.12
Manual Fell/Timberjack 230E/12" Morbark Model 12	13.24
Manual Fell/Clark Cable Skidder 664D/Morbark Model 12	13.65
Production of 100 tonnes per 8-hour shift:	
Manual Fell or Feller Buncher/Timberjack 350 Grapple Skidder, Trelan 18" Chipper	10.47
Manual Fell or Feller Buncher/Clark Grapple 665D/Trelan 18" Chipper	10.26
Manual Fell or Feller Buncher/Clark Grapple 665D/Morbark 550 18" Chipper	10.12
Manual Fell or Feller Buncher/Timberjack 350/Grapple Skidder, Morbark 550 18" Chipper	10.32

From Table 7 it can be seen that the lower cost systems for providing woodchips at roadside have been associated with the higher capacity systems. However, since this operation requires only 50 tonnes per day, the manual fell/Timberjack choker skidder/14" Trelan chipper system (or equivalent) is recommended.

There are a number of other costs which must be included to determine the processed chip cost at roadside (i.e. total cost of chips on the truck). They are presented in Table 8 as follows:

TABLE 8

PROCESSED CHIP COST AT ROADSIDE – TOTAL

Elements	Cost/Tonne
Roadside chipharvesting cost[1]	$12.70
Road Building[2]	0.71
Road Maintenance and Snowclearing[3]	1.00
Supervisor + Vehicle[4]	2.00
Scaling[5]	1.00
TOTAL	$20.02

The processed chip cost at roadside ($20.02 per tonne) was added to the trucking cost per tonne (Table 9) to give the total delivered cost per green tonne at each of the five potential end-user communities. These calculations were based upon hauling distances from the Ocean Pond blocks via the Lethbridge Access Road. It was assumed that winter delivery times from Block 10 would equal the summer-fall delivery from Block 15. Block 10 represented a reduced haul road distance of 18 km; however, since winter conditions would generally be more difficult hauling time would be roughly equal.

With chip cost determined, the remaining factor considerations to be addressed were storage, mill residue and chip production from small-scale operations.

A central storage yard was identified in the general chip supply area. Central storage was closer for the early production phase because it would present the fewest logistical complications. A site located near the intersection of the Lethbridge forest access road and the Bonavista Peninsula Highway (Figure 1). It is Crown land and is accessible throughout the year. It is suggested that the

---

[1]Determined from Table 7.

[2]$10,000 per km/14,000 tonnes per km of haul road = $0.71 where 14,000 is roughly 75 per cent of the average mass for Blocks 10 and 15.

[3] and [5]Estimate.

[4]Represents an allocation of more than $30,000 for these functions.

TABLE 9

CHIP COST AT PLANTS

End-User	Distance from Ocean Pond	Loading Hrs.	Unloading Hrs.	Travel Return Hrs.	Total[1] Hrs.	Trucking[2] Cost	Cost/Tonne[3]	Total[4] Delivered Cost
Arnold's Cove	102	.5	.25	2.2	2.95	103.25	10.33	30.35
Clarenville	52	.5	.25	1.3	2.05	71.75	7.18	27.20
Charleston	48	.5	.25	1.2	1.95	68.25	6.83	26.85
Catalina	96	.5	.25	2.1	2.85	99.75	9.98	30.00
Bonavista	112	.5	.25	2.5	3.25	113.75	11.38	31.40
							9.14	

[1]Even though Bloomfield is nearer to the end-users than Ocean Pond, it is assumed that winter deliveries will be slower, thereby equalling summer delivery times. Lethbridge Access Road assumed to be the haul route for above calculations.

[2]Trucking by Tandem pallet truck at a rate of $35/hr.

[3]The average cost per tonne for trucking is $9.14 based on 10 tonnes per load and this figure will be used for comparisons in this report.

[4]Total delivered cost = processed chip cost at roadside + delivery (cost/tonne).

storage yard contain 1,000 tonnes of whole trees. This, with the sawmill residue available at major mills, is adequate fuel for two months' downtime in the spring (April and May). As well, the whole trees could provide material to keep the chipper and trucks occupied for at least 20 days during spring breakup.

Since fuelwood requirements during the winter would be relatively modest because of plant slowdowns, 1,000 tonnes of whole trees in storage would be sufficient. Biomass could be purchased from local suppliers at a suggested rate of $17.50 per tonne ($35.00 per cord equivalent) at the yard or delivered to the storage yard by the prime contractor. It is recommended that the storage yard be located on the main highway to allow for all weather conditions.

It is assumed that a 1,000-tonne stockpile of biomass will be maintained by the prime contractor throughout the year. The cost of storage handling and delivery is developed in Table 10 for purchased biomass and Table 11 for biomass delivered to storage from the contractor's own operation.

TABLE 10
DELIVERED CHIP COST FROM PURCHASED STORAGE

	$/Tonne
Biomass (in yard)	17.50
Interest (10,000 x 17.50 x 15%/1,000 tonnes)	2.63
Chipping (8 hrs. per shift x 0.6 utilization x $44.28 per PMH)/50	4.25
Trucking	9.14
Scaling and Supervisory	2.00
	$35.52

TABLE 11
DELIVERED CHIP COST FROM CONTRACTOR'S STORAGE

	$/Tonne
Biomass[1] (in yard)	14.08
Interest: (1000 x 14.08 x 15%) 1000 tonnes	2.11
Chipping (see Table 10)	4.25
Trucking	9.14
Scaling and Supervisory[2]	1.50
	$31.08

It is highly unlikely that a 1,000-tonne stockpile shall be required throughout most of the year but the assumed carrying cost presented in the two tables should be sufficient to largely offset storage yard maintenance and the stockpiling of a quantity of wood chips. The tables also indicate that there would be a significant saving to the contractor if he were to provide his own biomass stockpile.

The mill residue cost per tonne is presented in Table 12. It should be noted that there is no widely established price for mill residue in this province. Residue markets have been extremely limited and a broadly based price structure has not been developed. However, based on prices elsewhere, the $10.00 price suggested in Table 12 would have to be considered as premium.

TABLE 12
DELIVERED COST FROM MILL RESIDUE

	$/Tonne
Residue in Van (estimate)	10.00
Scaling/Weighing	1.00
Trucking	9.14
	$20.14

---

[1]Breakdown: Biomass roadside = $8.45
Prep. for trucking = 1.25
Trucking (1.5 @ 35.00)/12 tonnes = 4.38

[2]Sole source supply would mean less supervision.

The small-scale chipping operation could account for up to 1,500 tonnes of chips. The cost calculations follow in Table 13.

TABLE 13
DELIVERED CHIP COSTS FROM INDEPENDENT OPERATORS

	$/Tonne
Biomass – Roadside	12.50
Chipping (detailed in Appendix 3)	5.61
Trucking – Average	9.14
Scaling/Measuring	1.00
	$28.25

It should be pointed out that in Table 13, costs, such as road-building and maintenance as well as supervisory costs, have been incorporated into the price of biomass at roadside, in summary fashion. Very few of the operators actually construct or maintain their own roads and, therefore, have very little expense in this regard. Without either haul road construction or a very mobile harvesting system, it can be assumed that their contribution to overall production shall remain at less than 10 per cent.

TABLE 14
SUMMARY OF DELIVERED FUELWOOD COSTS

Source	Tonnes	$/Tonne	Total
Main Contractor:			
Direct Delivery	9,500	20.02 + 9.14	$277,020
Storage	1,000	31.08	31,080
Mill Residue	3,000	20.14	60,420
Independent Operators	1,500	28.25	42,375
	15,000		$410,895

The average cost per tonne for processed fuelwood from the supply source to plant storage is $410,895/15,000 green tonnes = $27.40 per green tonne. On an oven-dry basis this would be: $410,895/8,250 O.D. tonnes = $49.81 per O.D. tonne.

DISCUSSION

The average delivered cost for processed fuelwood, which is in the $28.00 per green tonne range, provides for all significant direct and indirect costs plus contingencies and is based upon the assumption that there shall be a widely dispersed pattern of consuming plants supplied from a central operating area. For certain facilities this would mean a long haul (greater than 100 km) with a higher delivered price than for plants within close proximity to the biomass harvesting operation. Thus, every effort should be made to convert the nearest plants first. Communities such as Clarenville could be readily supplied using pallet trucks and should be considered prime candidate communities.

To improve delivery time it is recommended that the Ocean Pond Access Road be upgraded prior to the commencement of biomass harvesting. The Unit has formulated reconstruction plans for this road and the work should be undertaken once the commitment to plant conversion has been formalized. Delivery times to Clarenville and east shall be further improved when the proposed access road from the Trans-Canada Highway, at George's Pond, to the Bonavista Peninsula Highway, north of George's Brook, has been completed.

To ensure that the fuel wood procurement system is debugged as quickly as possible and that the role of the various participants is effectively developed, it is strongly suggested that the funding department retain a private firm, with an established record in forest operations, as project manager. The firm would be responsible for all facets of the operation for the first year, including delivery schedules, training and technical support for suppliers as well as purchasing, monitoring and performance.

The cost for this scenario is presented in Table 15 along with other non-recurring, first-year costs:

TABLE 15

NON-RECURRING COSTS (YEAR 1)

Project Management	$ 45,000.00
Underwriting – Year 1 Storage	20,000.00
Storage Yard Development	15,000.00
Chippers – Short-term Rental Incentive	20,000.00
– Demonstration Unit	20,000.00
	$125,000.00

The funding agency should anticipate these extraordinary costs in its first-year fuelwood supply program. The storage costs shall be completely recoverable but should be incurred at the outset to generate an immediate stockpile which would reassure the purchaser without placing an additional, initial burden on the prime contractor's finances.

Without a long-term supply contract, the contractor should not be expected to incur the full expense of storage yard development. Since a short-term contract is advisable, the $15,000 allocation should defray most of the yard construction costs. The contractor could either accept assistance and waive all proprietary rights or develop his own private yard.

The short-term nature of the agreement with the prime contractor shall mean an extraordinary rental cost. This cost should not be borne by the contractor.

It is obvious that a short-term agreement must be equated with additional cost and can be justified only on the basis that it provides the funding agency with the flexibility necessary to assure the success of the development. Specifically, the proposed arrangement could be evaluated at an early stage and revisions incorporated without the customary administration or legal entanglements.

The cost of providing a small capacity demonstration chipper to selected small operators for trial operation shall be recovered in

part. The rental should be assessed on the basis of machine cost and normal production at a per tonne rate. The rental will be $5.61 per green tonne for the $35,000 chipper costed earlier (Table 13, Appendix 3). Assuming that the entire 1,500-tonne allocation were produced, this would return $3,415 of revenue to the funding department but this would fall far short of total machine rental, maintenance cost, shipment and local moving cost, and general cost for delays which would be unavoidable with such a program.

It is, nevertheless, considered an important aspect of the overall project since the small operator has been a mainstay of the forestry sector of Unit 2 and should be able to make a significant contribution in the supply of fuelwood. To capitalize on this opportunity, interested operators in the small logging/sawmill sector should be given an opportunity to test the small chipper and be provided with basic training in chipharvesting. This would be part of the responsibility of the project management firm.

The firm would also have to expend considerable effort toward maximizing the use of mill residue as a fuelwood source. The opportunity for cost reductions to the purchaser, through the retrieval of greater quantities of residue, is obvious; however, most mill owners shall have to be convinced that it represents more than a temporary market and be assisted with the costing of necessary modifications to mill configurations.

Active support of a relatively broad base of suppliers is intended to stimulate competition from the outset. The prime contractor shall be the designated key supplier initially and be under the control of the funding department. The department should be in a position to relinquish this role within a couple of years and be assured of the continuation of the development if it has fostered competition among suppliers.

The immediate benefit, besides oil displacement, would be the

creation of 12 permanent full-time jobs in biomass harvesting, processing and delivery. It would also provide badly needed revenue to mill operators for a waste product and help secure the jobs of their employees.

To assist with the development of this new industry, it is suggested that the Department of Forestry and Lands be requested to delay the imposition of royalty on forest biomass and mill residue until such time as viability has been assumed.

CONCLUSION AND RECOMMENDATIONS

The average delivered cost for processed fuelwood was determined to be $27.40 per green tonne ($49.81 per O.D. tonne). It was assumed that forest biomass and mill residue was processed centrally in the vicinity of Goose Bay and transported in chip or shavings form to combustion plants in candidate communities dispersed throughout Unit 2. The cost was developed on the basis of a 15,000 green tonne requirement delivered to consumers throughout the year.

The economic implications of such a development were beyond the scope of this study. Suffice it to say that the economic impact would be significant. Twelve full-time permanent jobs would be created and job security in sawmilling enhanced.

Should the decision be made to capitalize on this opportunity, the following is recommended:

1. That the co-ordinating department assume overall responsibility for fuelwood procurement during the development period.
2. That the co-ordinating department retain a private firm as project manager for fuelwood procurement and program implementation.
3. That two-thirds of the fuelwood be supplied by a major contractor with smaller operators supplying the remainder as forest biomass and mill residue.
4. That choker wheeled skidders and a 14-inch capacity chipper, or equivalent, be utilized initially as the production equipment by the

prime (major) contractor.

5. That the prime contractor construct his own haul road and be granted temporary proprietary rights to control access to same.

6. That chipharvesting commence during the summer to fall period, irrespective of the startup date for the conversion plant.

7. That every effort be made initially to locate plants within reasonable proximity to the Goose Bay operating area.

8. That an operational survey be completed on those blocks identified for harvest during the first five years to provide accurate data for a harvesting plan and haul road location.

9. That the Ocean Pond Access Road be upgraded with consideration being given to relocating outer section.

10. That the biomass and chip storage yard be located near the intersection of the Lethbridge Access Road and the Bonavista Peninsula Highway (Route 230).

11. That the Department of Forest Resources and Lands refrain from imposing royalty on forest biomass and mill residue in Unit until the viability of the development has been assured.

BIBLIOGRAPHY

Bowater Newfoundland Limited. June 1981, **Harvesting Forest Biomass as an Alternate Fuel,** Enfor Project, p. 191.

Buggie, Bill. July 1982, **Report on Wood-chip Fuel Harvesting and Chipping Development Trial (FPD-WF-1) in Central Newfound-Land,** Report No. FPD-12.

Highlands Contracting Ltd. August 31, 1982, **Interim Report, Whole Tree Chipping Project,** Abitibi-Price Inc., Department of Mines and Energy.

J.P.R. Associates Inc. **Whole Tree Chippers Handbook,** May 1981.

Rogers, Ken E. October 1980, **Preharvest Drying of Logging Residue,** Forest Products Journal, December 1981.

Weldwood, R.W. (Undated), **Complete Tree Utilization: An Analysis of the Literature (1970-78), Pt. 1: Biomass of Forest Tree Components,** Enfor Project 15, Canadian Forest Service, Environment Canada.

APPENDICES

APPENDIX 1: Terms of Reference for Fuelwood Supply Study for the Bonavista Peninsula

APPENDIX 2: Biomass Tables

APPENDIX 3: Details of Study Method

APPENDIX 4: Calculation Sheets

APPENDIX 5: Study Area Maps

APPENDIX 6: Computer Printouts

APPENDIX 7: Equipment Specifications

APPENDIX 1

TERMS OF REFERENCE FOR FUELWOOD SUPPLY STUDY FOR THE BONAVISTA PENINSULA

GENERAL

The Department of Mines and Energy, through the Canada/ Newfoundland Conservation and Renewable Energy Demonstration Agreement, is developing a proposal to encourage conversions of a number of commercial and industrial boiler plants in the Bonavista Peninsula region to wood-burning systems and to demonstrate a complete fuelwood supply and utilization infrastructure.

The Unit Forester for Forest Management Unit #2 will identify areas with a potential for fuelwood. The objective of this study would be to assess the amount of wood fuel in these designated areas that is technically and economically recoverable and the infrastructure necessary to accomplish this.

SCOPE OF WORK

1. For areas designated by the Unit Forester, estimate the amount of biomass that is technically and economically recoverable over a period of approximately 20 years. The primary use for these particular areas would be for fuel, with a secondary use for pulpwood or lumber.

   Some variables in determining costs would be: The type, size and density of the timber, road access, terrain, ownership, distance to end-user harvesting and handling systems used and capabilities of the local woods contractors.

   In addition, determine the number of sawmills in the region and the amount of available wood waste from these mills.

2. Investigate harvesting options for fuel wood supply, including roadside chipping, terrain chipping and central processing. Identify types and approximate cost of equipment available for each option.

3. Investigate fuelwood handling options identifying the types and approximate cost of transportation and storage systems.

4. Provide a detailed operating plan for one year, a five-year harvesting plan and an estimate of the number of years such a level of harvesting could be sustained. Department of Forest, Resources and Lands will take this plan under advisement.

QUALIFICATIONS OF CONSULTANT

Experienced forester with knowledge of forestry operations in the province of Newfoundland.

APPENDIX 2
BIOMASS TABLES

The explanation of terms is as follows:

Stratum – As defined in the Forest Management Inventory of Newfoundland.

Total Biomass – The mass of the whole tree. The aggregate of Stump Wood + Stump Bark + Bole Wood + Bole Bark + Branch Wood + Branch Bark + Foliage.

Total Biomass figures were recently computed on a mass/area basis by the Inventory Division of the Department of Forest Resources and Lands in consultation with the Canadian Forestry Service. The Tables were generated in a computer run on October 19, 1982, and are expressed in O.D. Tonnes/ha.

Harvest Biomass = Total Biomass - Stump Biomass
= Total Biomass - (Stump Wood + Stump Bark)

Harvest Biomass figures were used for the calculation of mass since technology for harvesting stump biomass was not considered in this study.

Residual Harvest Biomass = Harvest Biomass - Merchantable Bole where Merchantable Bole = Merchantable Bole Wood + Merchantable Bole Bark. Residual Harvest Biomass figures were applied to stands which were designated for integrated logging and represent that portion of the mass of the whole tree which would be available following removal of the merchantable segment.

APPENDIX 2 (Cont'd)

HARVESTABLE BIOMASS TABLE
(O.D. Tonnes/ha)

Stratum	Total Biomass	Stump Biomass		Harvest Biomass
		Stump Wood	Stump Bark	
BF 31	110.37	1.00	0.16	109.21
32	84.27	0.86	0.13	83.28
33	57.80	0.60	0.09	57.11
42	109.36	1.45	0.23	107.68
43	77.12	1.05	0.16	75.91
52	116.36	1.88	0.31	114.17
53	94.02	1.54	0.25	92.23
BS 31	173.53	1.71	0.24	171.58
32	111.49	0.95	0.13	110.41
33	128.58	0.66	0.09	127.83
41	216.55	2.71	0.38	213.46
42	158.88	2.10	0.30	156.48
43	68.01	0.87	0.12	67.02
52	223.52	3.45	0.48	219.59
HS 42	124.61	1.82	0.29	122.50
43	69.72	1.01	0.16	68.55
52	109.55	1.84	0.30	107.41
SH 32	50.54	0.63	0.09	49.82
33	84.21	0.91	0.15	83.15
42	123.38	1.66	0.25	121.47
43	92.52	1.19	0.19	91.14
52	135.15	2.09	0.33	132.73
53	135.28	2.27	0.37	132.64
WB 32	50.03	0.62	0.10	49.31
41	80.70	1.41	0.24	79.05
42	87.65	1.47	0.24	85.94
43	57.68	1.02	0.17	56.49
52	79.42	1.42	0.24	77.76
53	136.75	2.25	0.42	134.08
BF 30[1]				110.00

[1] Assigned Value

APPENDIX 2 (Cont'd)

RESIDUAL HARVEST BIOMASS TABLE
(O.D. Tonnes/ha)

Stratum	Total Harvest Biomass	Merchantable Bole		Residual Harvest Biomass
		Wood	Bark	
BF 42	107.68	37.15	4.97	65.56
BF 52	114.17	49.36	7.24	57.57
BS 42	156.48	51.46	5.31	99.71
BS 52	219.59	89.21	8.88	121.50
SH 42	121.47	36.65	3.96	80.86
SH 52	132.73	23.77	2.76	106.20

APPENDIX 3

DETAILS OF STUDY METHOD

The study method is composed of two sections: (1) forestry data development and (2) equipment and systems data development.

FORESTRY DATA DEVELOPMENT

The assessment of areas suitable for chipharvesting originated with stands designated by the Unit 2 Forester. These stands, identified on a series of 1:30,000 forest type maps were widely disbursed over most of the productive forest area within the Unit. The Unit's objective was to minimize loss of commercial sawlog and pulpwood stands to chipping and designated primarily those stands which fell into one of the following categories:

1. Softwood and softwood-hardwood stands from which the merchantable component, particularly the sawlogs, had been removed.
2. Hardwood stands outside the hauling range of domestic cutters.
3. Dense submerchantable softwood (rail type) stands in the mature to over-mature age class.
4. Damaged stands without significant sawlog material.

The maps were reviewed and stands were eliminated on the basis of conventional logging criteria other than volume (e.g. inaccessible, isolated and the like). Stands or portions thereof identified by Unit staff as existing or potential (i.e. stands in close proximity to communities) domestic firewood sources were eliminated.

The remaining stands were reconsidered by the Unit Forester and the Senior Inventory Technician to identify changes in stand characteristics resulting from disturbances since the inventory had been completed six years previously. Stands, or portions thereof, were classed as either heavily, moderately or lightly disturbed and stand

typing revised (e.g. BF 342 m to BF 343 m) where applicable.

This led to the elimination of stands, or portions thereof, which had been very heavily highgraded (i.e. those which could be classed as the very low volume stand reclaimation type stands).

The remaining designated stands were considered for grouping into harvesting blocks. Again, conventional logging criteria, excepting volume considerations, were applied. A haul road network was then identified and block boundaries were established. These blocks (totalling 18 and demarcated in Appendix 8) along with stands within an average hauling distance of 450 m of an existing suitable roadside landing were established as the effective study area.

Field checks were made on stands in each block with emphasis on those in the moderate to heavily disturbed categories. The intensity of the ground checking on each block varied with the degree of certainty which Unit personnel felt applied to their stand assessments.

This procedure led to the preparation of a revised stand area list with updated, general stand typing. Stand volumes were calculated using the Biomass Tables (Appendix 2). Calculation sheets developed for Block summaries are contained in Appendix 5, this outline method.

EQUIPMENT AND SYSTEMS DATA DEVELOPMENT

The choice of equipment analyzed was based on local knowledge of supplier service and reliable machinery. Written quotes were obtained from local equipment suppliers. Any logging equipment and chippers were analyzed by computer. Trucking is based on public utility rates.

Following is a list of the input data for the computer to produce productive machine hour costs as well as an explanation of

where the data comes from.

LOGGING EQUIPMENT AND CHIPPERS $PMH
INPUT FOR COMPUTER ANALYSIS

MACHINE COST PMH

Unit Cost – Equipment Supplier

Residual Value – 10% of Capital Cost

Life of Machine Meter Hours – 10,000 hrs.

Scheduled Hours/Shift – 8

Shifts/Day – 1

Operating Days/Year – 210

Average Utilization – Varied estimates (W.S.) based on actual cases

Interest Rate – 15% (estimate) (W.S.) economy fluctuations over past three years do not allow firm interest rate

Insurance – From supplier or estimate

Licence – Not applicable

LABOUR AND REPAIR

Fuel Consumption – Supplier and Estimate

Fuel Type Cost – Diesel Irving Oil, Gander (Tax Exempt)

Hydraulic Oil and Lube – Supplier and Estimate (W.S.)

Operators:

Number per Shift – 1

Operator Wages $/Hour – $8.00 across the board for all operators

Average Shift Differential – Not applicable unless two shifts/day

Fringe Benefits – 21% of operator's rate

Repair – 100% of capital cost over five years

CRITERIA

1. Five-year write-off period.
2. Residual value is 10% of capital cost. This is adjusted on some suppliers' quotes.
3. The wood harvesting is based entirely on a green metric tonne and converted to oven dry after the entire analysis. Production estimates are based on reasonable equipment ratings and field analysis.

Once $PMH rates were obtained, the varied components of the two systems were analyzed. The two systems are as follows:

Manual Fell	Manual Fell (could be replaced by Feller/Buncher
Choker Skidder	Grapple Skidder
12" or 14" Chippers	18" Chippers
Production: 50 tonnes/day	100 tonnes/day

Trucking was looked at using vans and a Humper or self-dumping vans and self-dumping pallet trucks. The machine components are compared in the "Analysis of Systems" section of this report.

In the computer system analysis, all machine components were compared to each other for cost performance. Following is a list of the data input for system analysis.

STUMP TO CHIPS IN VANS

System Analysis:

Operating days per year – 210
Code name of each operating area
Volume of Wood – assumed supply available
Number of systems analyzed in that area
Name of first system
Final wood form – Green metric tonnes
Volume to be produced by the system in area
Number of machine types
Name of each machine type
Scheduled shifts per day – 1
Scheduled manhours per shift – 8
Number of machines used in that area
Machine utilization
Productivity, tonnes/hour
Operators per machine per shift – 1
Machine rental rate – As calculated

The storage component of the chip supply program was considered to be kept to a minimum. However, costs for storage yard construction, trucking and carrying costs are considered in the "Analysis of System" section.

All pertinent forestry and equipment production data were correlated and a systems analysis completed.

COST CALCULATIONS FOR SMALL-SCALE CHIPPER

Total Cost = $35,000 Residual Value = $3,500 5-year write-off

Average Investment = $\frac{(35{,}000)(5+1)+(3{,}500)(5-1)}{2(5) \text{ or twice life}}$ = $22,400

Yearly Depreciation = $35,000/5	$7,000
Yearly Interest = $22,400 x 15%	3,360
Yearly Insurance = $22,400 x 3%	672
Yearly Repairs (100% of capital cost over 5 years)	7,000
Yearly Fuel and Related	3,150
Total Yearly Chipper Cost	$21,182
Yearly Production (18 tonnes x 210 days)	3,780 tonnes
Average Chipper Cost per Tonne = $21,182/3,780 =	$5.61

APPENDIX 4

CALCULATION SHEETS ON BLOCK/STAND GROUP DATA DEVELOPMENT

NOTES:

Stratum tabulated represents revised and not original stand typing as recorded in the management inventory data files.

Area tabulated represents area within the boundaries of conventional hauling limits and not the total stand area as recorded in the management inventory data files.

H/D (Harvesting Designation) indicates that the stand is (1) either recommended for harvesting to chips only or (2) recommended for integrated logging with the conventional merchantable component (i.e. the merchantable bole) going to sawlogs and/or pulpwood with the remainder going to chips.

Mass was calculated using the Biomass Tables in Appendix 2. The mass figure for each stand represents total stand mass for those which are to go exclusively to chips (i.e. 'C' under harvesting designation) and represents only the residual mass available for chipping where integrated logging is recommended (i.e. 'I' under harvesting designation).

T.C.H. AREA WEST OF CLARENVILLE

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #1: White Hills Road Area						
116-44	101	BS 43	13.1	C	878.0	
"	93	SH 43	26.6	C	2,424.3	
"	66	SH 43	8.9	C	811.2	
"	60	WB 43	9.7	C	546.0	
"	61	SH 42	24.3	C	2,951.7	
"	62	HS 43	8.4	C	575.8	
"	63	SH 43	15.4	C	1,403.6	
"	64	BS 43	4.5	C	301.6	
"	12	HS 42	46.4	C	5,684.0	
"	14	BS 42	5.3	C	829.3	
"	13	BS 43	3.7	C	248.0	
"	71	BS 43	4.3	C	288.2	
"	70	WB 42	27.7	C	2,380.5	
"	65	SH 43	15.3	C	1,394.4	
"	72	HS 43	12.2	C	836.3	
"	73	HS 43	1.5	C	102.8	
			227.3		21,655.7	Avg. = 95.3 Tonnes/ha Haul Roads = 3.7 km
Block #2: White Hills Road Area						
116-44	97	WB 43	7.6	C	429.3	
"	138	SH 43	16.3	C	1,485.6	
"	139	HS 43	36.5	C	2,502.1	
"	140	SH 32	18.9	C	941.6	
"	137	BF 43	7.8	C	592.1	
			87.1		5,950.7	Avg. = 68.3 Tonnes/ha Haul Road = 0.9 km

Map indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
H/D indicates harvesting designation either chipping (C) or Integrated (I).

T.C.H. AREA WEST OF CLARENVILLE

Map	Stand	Stratum	Area (ha)	H/D	Mass(Tonnes/ha)	Remarks
Roadside Stands (Outside Blocks), White Hills Road						
116-44	68	HS 43	19.8	C	1,357.3	
"	67	BF 32	13.0	C	1,082.6	
"	59	SH 43	14.8	C	1,348.9	
			47.6		3,788.8	Avg. = 79.6 Tonnes/ha
Block #3: North of Shoal Hr. River at T.C.H. Bridge						
116-44	131	SH 42	60.1	C	7,300.4	
"	132	HS 43	5.6	C	383.9	
"	179	SH 43	33.9	C	3,089.6	
"	130	HS 42	16.2	C	1,984.5	
"	129	HS 20	–	–	–	
"	128	WB 42	7.3	C	627.4	
"	180	SH 42	26.5	I	2,142.8	
"	184	SH 43	46.4	C	4,228.9	
"	125	BS 43	34.1	C	2,285.4	
"	127	SH 42	10.9	I	881.4	
"	126	BS 42	4.0	I	398.8	
"	124	HS 43	10.2	C	699.2	
"	117	SH 43	48.6	C	4,429.4	
"	122	SH 42	47.9	I	3,873.2	
"	118	HS 42	26.7	C	3,270.8	
"	119	SH 42	16.9	C	2,052.8	
"	113	BS 42	2.1	C	328.6	
"	121	HS 43	11.9	C	815.8	
			409.3		38,792.9	Avg. = 94.8 Tonnes/ha Haul Roads = 4.0 km 22% of area to integrated logging

Map indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second
H/D indicates harvesting designation either chipping (C) or integrated (I).

T.C.H. AREA WEST OF CLARENVILLE

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #4: North of T.C.H. opposite Thorburn Lake						
103-13	100	HS 43	5.3	C	363.3	
"	101	SH 43	5.3	C	483.0	
103-14	85	SH 43	11.7	C	1,066.3	
"	84	HS 43	108.7	C	7,451.4	
"	87	BF 42	5.1	C	549.2	
"	86	HS 42	3.3	C	404.2	
			139.4		10,317.4	Avg. = 74.0 Tonnes/ha Haul Roads = 2.0 km
Block #5: Dark Hole Brook Road						
116-34	48	BS 42	21.9	I	2,183.6	
"	20	BS 42	10.9	I	1,086.8	
"	21	BS 42	8.9	I	887.4	
"	19	BS 42	16.1	I	1,605.3	
"	13	BF 42	127.3	I	8,345.8	
"	14	BF 32	4.9	C	408.1	
"	57	BF 32	47.9	C	3,989.1	
"	56	BF 42	72.8	I	4,772.8	
"	58	BF 42	7.1	I	465.5	
			317.8		23,744.4	Avg. = 74.7 Tonnes/ha

Map indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
H/D indicates harvesting designation either chipping (C) or integrated (I).

GEORGE'S BROOK ACCESS ROAD

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #6: George's Brook Road Area						
117-41	101	SH 43	122.1	C	11,128.2	
116-44	169	SH 43	22.7	C	2,068.9	
"	35	SH 43	12.9	C	1,175.7	
"	36	SH 42	4.3	C	522.3	
117-41	4	SH 42	3.9	C	473.7	
"	1	BS 42	5.1	C	798.0	
"	2	SH 43	50.6	C	4,611.7	
"	3	BS 43	6.7	C	449.0	
"	9	BS 42	6.8	C	1,064.1	
"	5	BS 42	0.3	C	46.9	
"	6	BS 43	11.3	C	757.3	
"	8	HS 43	45.5	C	3,119.0	
"	12	BS 42	3.7	C	579.0	
			295.9		26,793.8	Avg. = 90.6 Tonnes/ha Haul Roads = 2.4 km
Block #7: George's Brook Road Area						
104-11	94	HS 42	53.6	C	6,566.0	
"	93	SH 43	11.5	C	1,048.1	
"	99	SH 43	31.6	C	2,080.0	
"	98	HS 43	0.6	C	41.1	
"	97	BS 42	8.6	C	1,345.7	
"	96	HS 43	6.0	C	411.3	
"	54	BS 42	4.9	C	766.8	
103-14	106	SH 43	1.1	C	100.2	
"	107	SH 42	38.4	I	3,105.0	
"	108	HS 42	16.0	C	1,960.0	
"	105	HS 43	25.5	C	1,610.9	
			197.8		19,035.1	Avg. = 96.2 Tonnes/ha Haul Road = 1.7 km 18% of area to integrated logging

"Map" indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
"H/D" indicates harvesting designation either chipping (C) or integrated (I).

GEORGE'S BROOK ACCESS ROAD

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block # 8: George's Brook Access Road						
104-11	47	BS 43	5.6	C	375.3	
"	42	SH 43	48.3	C	4,402.1	
"	43	SH 42	14.6	C	1,773.5	
"	45	BS 42	6.8	C	1,064.1	
"	58	SH 43	71.0	C	6,470.9	
"	46	BS 42	1.8	C	281.7	
			148.1		14,367.6	Avg. = 97.0 Tonnes/ha Haul Road = 1.1 km
Roadside Stands (Outside Blocks) along George's Bk. Road						
104-11	54	BS 42	14.4	I	1,435.8	
"	53	BS 42	8.9	I	887.4	
"	51	SH 42	11.2	C	1,360.5	
"	50	BS 42	5.9	I	588.3	
"	7	BS 42	7.0	I	698.0	
"	8	BS 42	5.2	I	518.9	
"	90	BS 42	9.0	I	897.4	
"	89	BS 42	16.1	I	1,605.3	
103-14	167	SH 43	14.0	C	1,276.0	
			91.7		9,267.6	Avg. = 101.1 Tonnes/ha

Map indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
H/D indicates harvesting designation either chipping (C) or integrated (I).

BLOOMFIELD ACCESS ROAD

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #9: Bloomfield Rd.						
104-21	43	BF 33	224.4	C	12,815.5	
"	42	BS 32	11.8	C	1,302.8	
"	11	BF 43	10.3	C	781.9	
"	48	BS 43	45.1	C	3,022.6	
			291.6		17,922.8	Avg. = 61.4 Tonnes/ha Haul Road = 1.9 km
Block #10: Bloomfield Rd.						
104-21	52	SH 53	76.8	C	10,186.8	
"	50	SH 53	16.3	C	2,162.0	
"	51	BS 31	3.8	C	652.0	
"	53	BS 42	5.2	C	813.7	
			102.1		13,814.5	Avg. = 135.3 Tonnes/ha Haul Road = 0.7 km

Map indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
H/D indicates harvesting either chipping (C) or integrated (I).

Map	Stand	Stratum	Area (ha)	H/D	Mass/Tonnes/ha)	Remarks
Block #11: Bloomfield Rd.						
103-24	216	SH 43	4.6	C	419.2	
"	215	SH 43	18.1	C	1,649.6	
"	133	SH 43	2.0	C	182.3	
"	132	HS 43	27.1	C	1,857.7	
"	131	BS 22	–	–	–	
104-21	147	BS 42	7.0	C	1,095.4	
"	146	SH 43	24.6	C	2,242.0	
103-24	214	BS 42	3.0	C	469.4	
"	134	SH 43	25.6	C	2,333.2	
"	137	BS 42	33.0	I	3,290.4	
"	135	HS 43	3.6	C	246.8	
"	144	BS 22	–	–	–	
"	143	SH 42	61.8	I	4,997.2	
"	145	HS 42	29.4	C	3,601.5	
"	146	BS 42	12.4	C	1,940.4	
"	141	BS 43	7.2	C	482.5	
"	112	WB 52	41.8	C	3,250.4	
"	121	SH 43	19.5	C	1,777.2	
"	120	BS 42	11.6	I	1,150.6	
"	119	SH 42	49.5	I	4,002.6	
"	123	BS 43	55.9	C	3,746.4	
"	122	HS 43	14.4	C	987.1	
"	140	BS 42	27.4	I	2,732.0	
"	130	BS 42	33.5	I	3,340.3	
"	139	BS 22	–	–	–	
"	138	BS 42	9.2	I		
			522.2		45,794.2	

Avg. = 87.7 Tonnes/ha
Haul Road = 6.4 km
43% of area to integrated logging

"Map" indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
"H/D" indicates harvesting designation either chipping (C) or integrated (I).

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #12: Bloomfield Rd.						
104-21	152	HS 43	25.9	C	1,775.4	
"	157	SH 43	37.0	C	3,372.2	
"	156	SH 43	15.7	C	1,430.9	
"	158	BS 42	5.9	C	923.2	
104-11	11	SH 42	4.2	C	510.2	
104-21	155	SH 43	10.9	C	993.4	
			99.6		9,005.3	Avg. = 90.4 Tonnes/ha Haul Road = 0.8 km
Roadside Stands (Outside Blocks) along Bloomfield Rd.						
104-21	70	BF 43	9.7	C	736.3	
"	66	BS 31	5.7	C	978.0	
"	72	BS 43	10.2	C	683.6	
103-24	211	SH 43	9.3	C	847.6	
"	209	SH 43	4.5	C	410.1	
"	208	WB 42	15.0	C	1,289.1	
			54.4		4,944.7	Avg. = 90.9 Tonnes/ha

Map indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
H/D indicates harvesting designation either chipping (C) or integrated (I).

OCEAN POND AREA

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #13: Ocean Pond Road						
104-13	48	BF 30	315.6	C	34,716.0	
"	120	BF 42	16.3	I	1,068.6	
"	124	BF 52	14.0	I	806.0	
"	111	BS 42	9.2	C	1,439.6	
"	108	BF 30	17.3	C	1,903.0	
"	110	BF 30	5.5	C	605.0	
"	109	SH 42	11.2	I	905.6	
"	64	BF 52	20.2	I	1,162.9	
"	65	BS 42	30.8	I	3,071.1	
"	105	SH 43	8.6	C	783.8	
"	107	BS 43	7.4	C	496.0	
"	125	SH 43	23.3	C	2,123.6	
"	126	SH 53	12.6		1,671.3	
			492.0		50,752.5	Avg. = 103.2 Tonnes/ha Haul Road = 2.7 km 19% of area to integrated logging

"Map" indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
"H/D" indicates harvesting designation either chipping (C) or integrated (I).

OCEAN POND AREA

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #14: Ocean Pond Road						
104-13	48	BF 30	49.1	C	5,401.0	
"	50	BF 32	–	–	–	
"	49	BF 20	–	–	–	
104-23	230	BS 32	–	–	–	
"	229	BF 20	–	–	–	
"	231	BS 20	–	–	–	
"	232	BS 42	5.2	C	1,330.1	
"	233	SH 43	16.2	C	1,476.5	
"	133	BF 20	–	–	–	
"	134	SH 43	10.2	C	929.6	
"	135	BS 42	7.7	C	1,204.9	
"	136	SH 43	6.3	C	574.2	
"	227	SH 43	20.2	C	1,841.0	
"	219	BS 32	7.7	C	850.2	
"	138	SH 43	52.5	C	4,784.8	
"	139	BS 42	4.0	C	625.9	
"	140	BF 42	12.0	I	786.7	
			191.1		19,804.9	Avg. = 103.7 Haul Road = 1.2 km 6% of area to integrated logging

"Map" indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
"H/D" indicates harvesting designation either chipping (C) or integrated (I).

OCEAN POND AREA

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #15: Lethbridge Road						
104-13	48	BF 30	19.2	C	2,112.0	
"	48	BF 30	17.8	C	1,958.0	
"	42	BF 20	–	–	–	
"	43	BF 33	13.0	C	742.4	
"	35	BS 33	37.8	C	4,832.0	
104-23	209	BS 33	19.4	C	2,479.9	
"	210	BS 33	15.1	C	1,930.2	
104-13	34	BF 20	–	–	–	
"	33	BS 42	11.1	C	1,736.9	
"	26	HS 43	5.4	C	370.2	
"	36	SH 42	2.9	C	352.3	
"	29	WB 43	17.6	C	994.2	
"	32	BF 20	–	–	–	
"	45	BS 42	6.2	C	970.2	
			165.5		18,478.3	Avg. = 111.6 Tonnes/ha Haul Road = 1.1 km

"Map" indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map. No. Second.
"H/D" indicates harvesting designation either chipping (C) or integrated (I).

BLACKHEAD BAY AREA (BONAVISTA)

Map	Stand	Stratum	Area (ha)	H/D	Mass (Tonnes/ha)	Remarks
Block #16: South of Upper Amherst Cove						
92-13	26	BF 33	86.3	C	4,928.6	
"	48	BF 30	13.7	C	1,507.0	
92-12	56	BF 33	10.9	C	622.5	
92-13	27	BF 31	98.9	C	10,800.9	
"	42	BF 30	70.6	C	7,766.0	
"	41	BF 30	26.0	C	2,860.0	
			306.4		28,485.0	Avg. = 93.1 Tonnes/ha Haul Road = 2.0 km
Block #17: South of Rolling Cove						
92-12	100	BF 30	36.1	C	3,971.0	
"	99	BS 32	6.7	C	739.8	
"	109	BF 30	14.0	C	1,540.0	
"	73	BS 42	81.0	I	8,076.5	
"	110	BF 10	–	–	–	
"	108	BF 20	–	–	–	
"	114	BS 42	80.0	I	7,976.8	
			217.8		22,304.1	Avg. = 102.4 Tonnes/ha Haul Road = 2.3 km 74% of area to integrated logging
Block #18: South of Rolling Cove						
92-12	98	BS 43	32.6	C	2,184.8	
"	75	BF 30	48.7	C	5,357.0	
"	87	BS 42	32.2	I	3,210.7	
"	86	BS 42	13.8	I	1,376.0	
			127.3		12,128.5	Avg. = 95.3 Tonnes/ha Haul Road = 1.0 km 36% of area to integrated logging

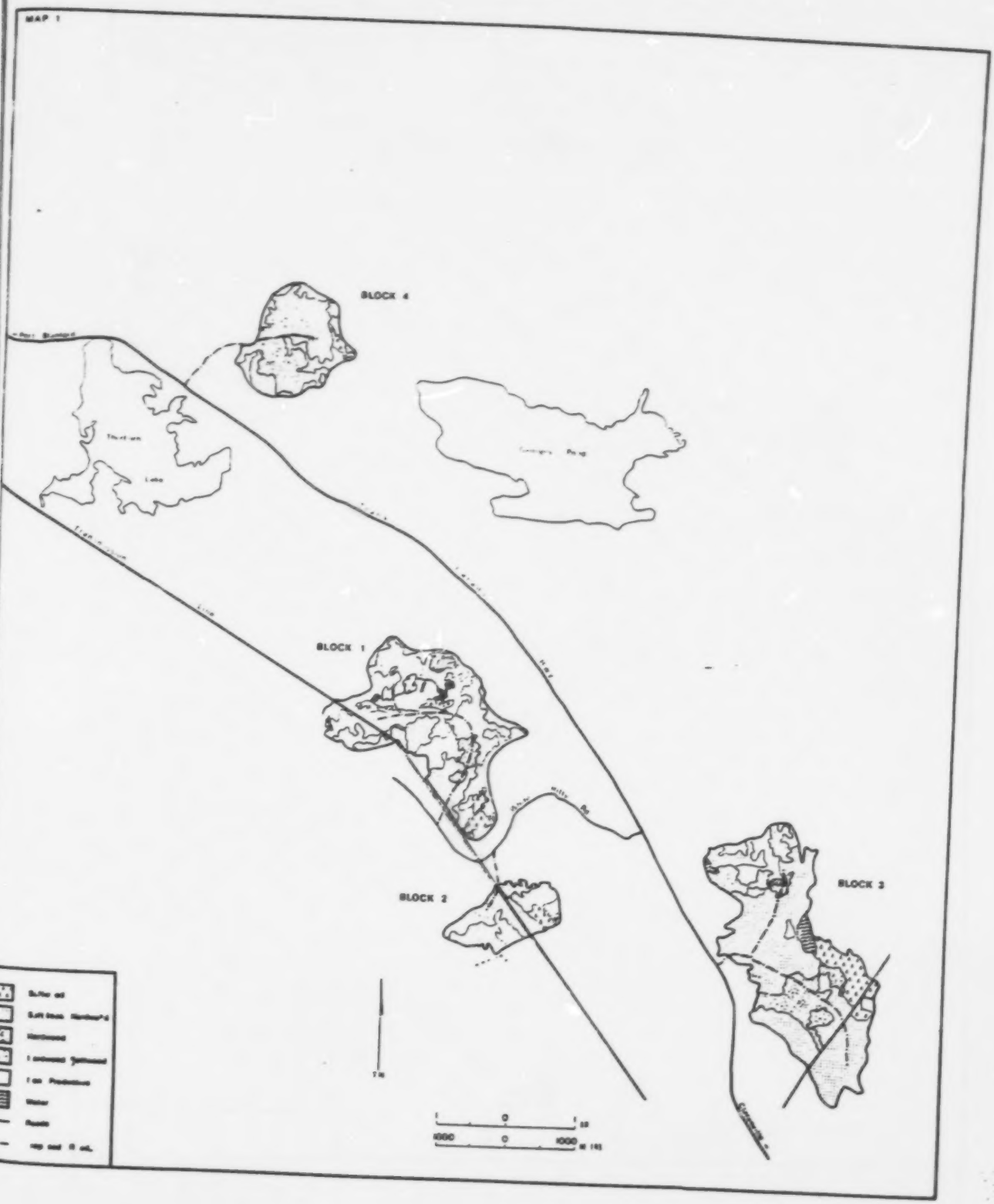
"Map" indicates Provincial 1:50,000 Index No. First and 1:30,000 Type Map No. Second.
"H/D" indicates harvesting designation either chipping (C) or integrated (I).

APPENDIX 5

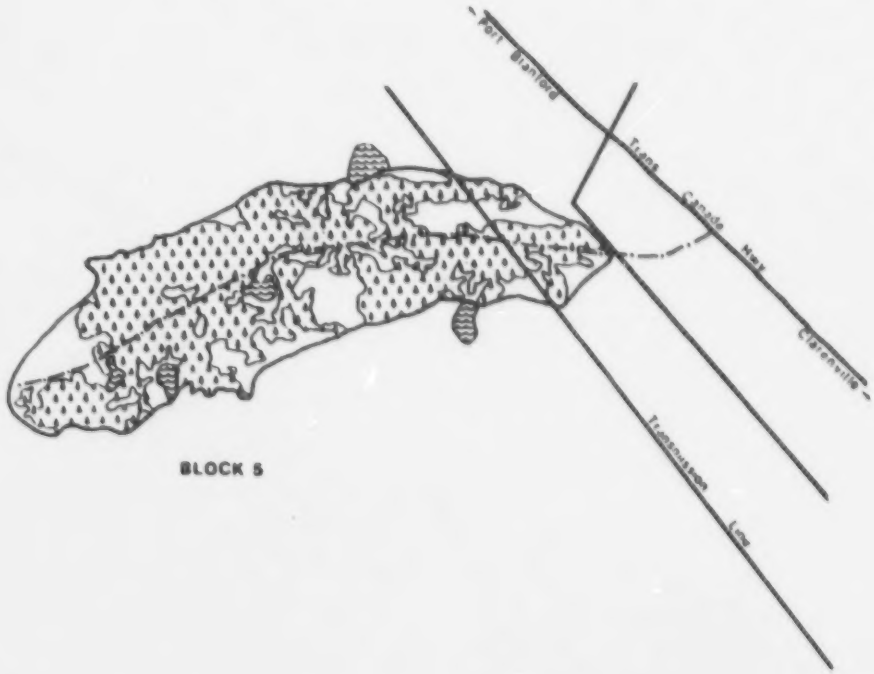
STUDY AREA MAPS

APPENDIX 5

STUDY AREA MAPS (1-5)



MAP 2



Softwood

Softwood Hardwood

Hardwood

Hardwood Softwood

Non Productive

Water

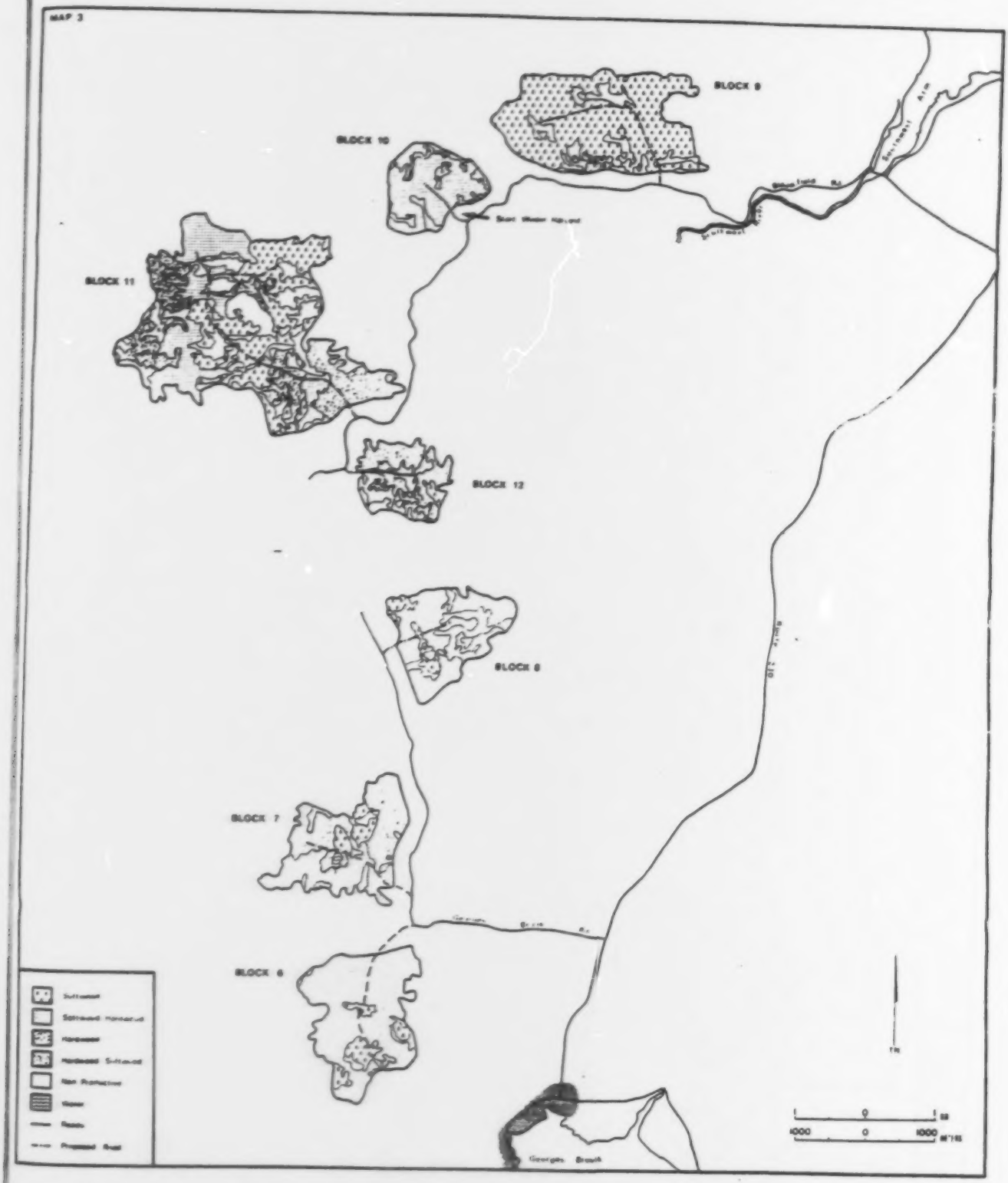
Roads

Proposed Road

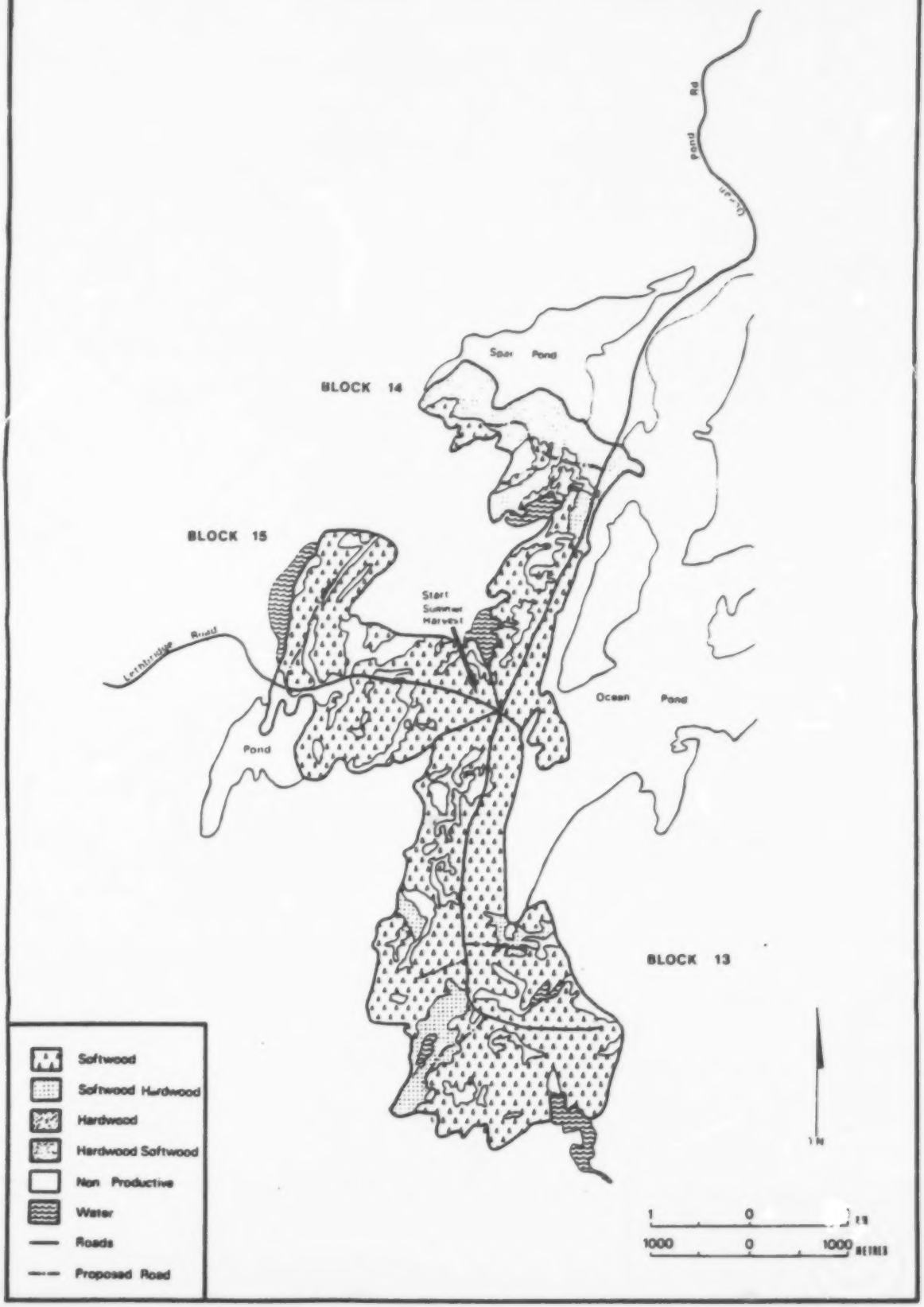
TN

1 0 1 KM

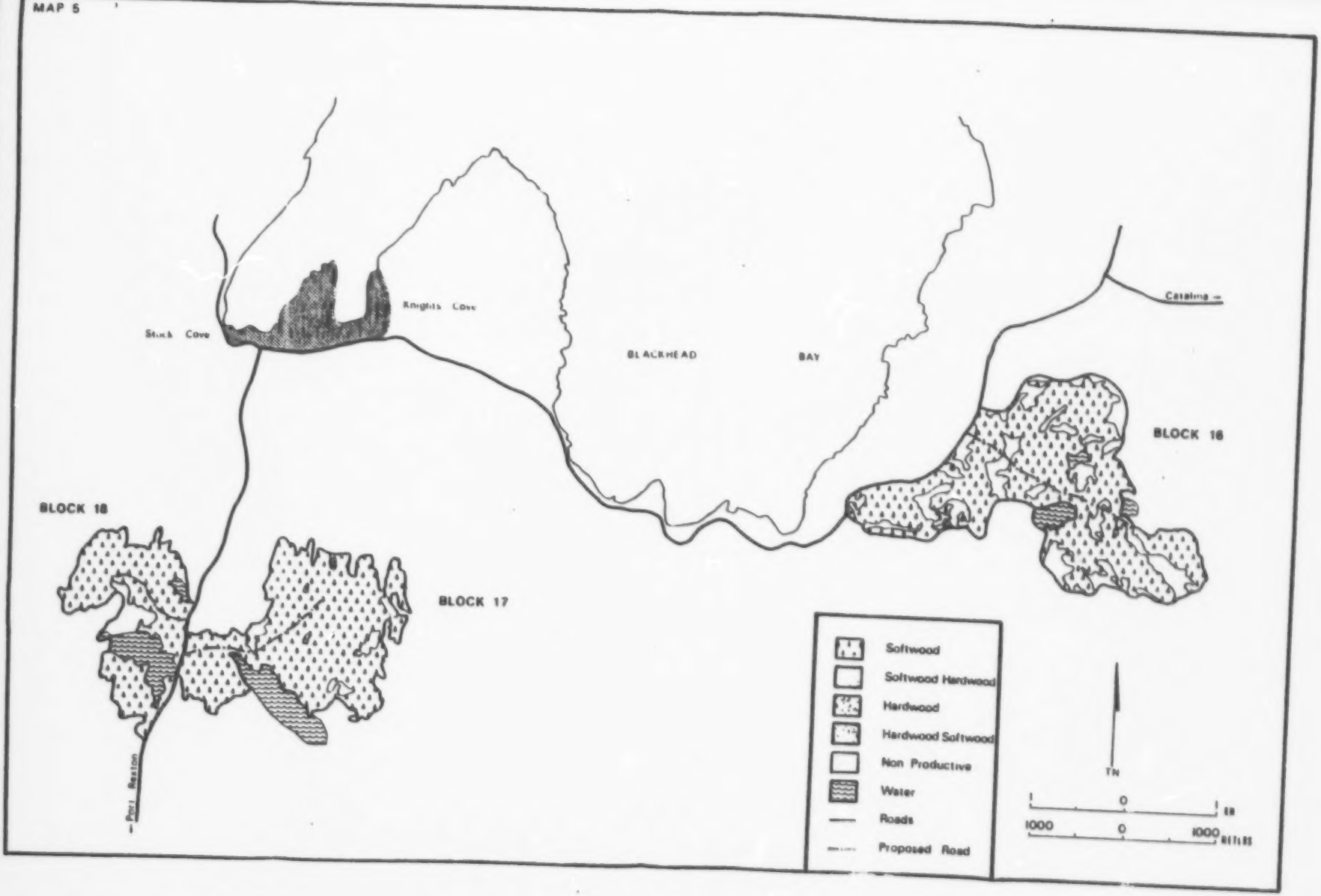
1000 0 1000 METRES


MAP 3
BLOCK 9
BLOCK 10
BLOCK 11
BLOCK 12
BLOCK 8
BLOCK 7
BLOCK 6
Georges Brook
1000 0 1000 M'TRS

MAP 4


Pond Rd
Soan Pond
BLOCK 14
BLOCK 15
Start Summer Harvest
Lethbridge Road
Ocean Pond
Pond
BLOCK 13
Softwood
Softwood Hardwood
Hardwood
Hardwood Softwood
Non Productive
Water
Roads
Proposed Road
1000 0 1000

MAP 5


Knights Cove
BLACKHEAD
BAY
Catalina
BLOCK 16
BLOCK 18
BLOCK 17
Port Rexton
Softwood
Softwood Hardwood
Hardwood
Hardwood Softwood
Non Productive
Water
Roads
Proposed Road
TN
1000
0
1000
METRES

APPENDIX 6

NOTE:

The computer analysis printout sheets of machine cost, and operations' evaluation, which make up this appendix, have not been reproduced here. They are in the original copy in the Department of Energy Library. Doc # 000211
CREDA Study # CS 85-50